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RESEARCH PAPERS

Effect of Bottle Colour and Storage Conditions on the Quality of Soursop *(Annona muricata)* Drink

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The effect of bottle colour and storage conditions on the quality of processed soursop drink was studied at representative Nigerian marketing conditions over a period of three months. Total sugars, reducing sugars, ascorbic acid, titratable acidity, pH and total soluble solids were determined. The results showed that samples stored in the refrigerator (5-8°C) remained unchanged both chemically as well as organoleptically. Greater changes were observed in samples directly exposed to sunlight while those stored on a shelf underwent lesser changes. Storage at refrigeration temperature, filling in green bottles and storing under shade (room temperature) was found to have good organoleptic qualities and less nutrient loss.

Ezekwe[1] has successfully produced a palatable drink from soursop in Nigeria. Similar beverages have already been marketed in the Philippines[2], Puerto Rico[3], Venezuela[4], and Singapore[5]. Ezekwe[1] reported that soursop drink bottled in clear glass bottles and stored at ambient temperature (30°C) on a shelf, detriorated fast in colour and lost about 57 per cent of its ascorbic acid within three months of storage. Similar changes have been observed in other stored fruit juices[6,7].

In the developing countries, due to paucity of refrigeration facilities fruit drinks are often displayed in the open sun which leads to impairment of quality. The present study was undertaken to estimate the extent of nutrient loss and deteriorative changes in soursop drink bottled and stored under the prevailing marketing conditions in Nigeria.

Materials and Methods

Raw material and production of drink: The soursop fruit (*Annona muricata*) was purchased from market in Nsukka, Anambra State, Nigeria. The fruits were washed, peeled, cored and deseeded. After extracting the pulp, it was diluted to 6° Brix and sweetened with 8 per cent sugar (w/v). It was processed at boiling temperature for 10 min and filled hot in glass bottles and cooled.

Methods of storage: Soursop drink was stored in transparent, green or brown bottles and stored under refrigeration (5-8°C), on a laboratory shelf (28-32°C) and in the sun (40-45°C). The nine combinations studied were: 1) transparent bottles in a refrigerator, 2) transparent bottles on a shelf, 3) brown bottles on a shelf, 4) green bottles on a shelf, 5) transparent bottles in a cardboard carton on a laboratory shelf, 6) transparent bottles in the sun, 7) brown bottles in the sun, 8) green bottles in the sun, and 9) transparent bottles in a cardboard carton placed in the sun. This facilitated the study of the effect of sunlight and the effect of bottle colour on the nutrient changes in the soursop drink.

Analysis of drink: Freshly prepared or stored soursop drinks were analysed; analysis of stored products were conducted at weekly intervals. The total soluble solids (TSS) were measured using the Abbe refractometer. The titratable acidity was determined by direct titration with 0.1N NaOH; the pH was also measured.

Reducing sugar was determined colorimetrically by the revised method of Folin and Wu[8]. Non-reducing sugars were estimated from the increase in reducing sugars after HCl-hydrolysis of an aliquot of the drink. The ascorbic acid content of the samples was assayed using the 2,6 dichlorophenol indophenol visual titration method, as described in the Methods of Vitamin Assay[9].

Organoleptic evaulation: The consumer acceptance of the product was done at the end of three months storage using freshly prepared drink as the standard. This was done by a taste panel of 7 members who were familiar with the drink. Preferences for colour, mouth feel and overall acceptability were indicated on 7-point hedonic scale where 7 indicating like very much to 1 indicating dislike very much.

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Results and Discussion

Changes in pH and acidity of the product during storage: There was no change either in pH or acidity of the beverage under refrigerated storage. In all other treatments pH increased slightly from 3.78 to 3.89 and acidity decreased from 0.42 to 0.36 per cent (13 per cent loss). This small increase could be due to leaching of alkali from the bottle and the consequent increase in pH or decrease in acidity due to higher storage temperature. Small changes in titratable acidity and pH have been reported for fruit juices during storage[10].

Changes in total soluble solids and sugars: Initial TSS content of 13.0° Brix remained unchanged in refrigerator stored and those kept in shade. But little increase in TSS was observed in samples stored in the sun (Table 1). In these, the bottles packed in carton were most affected especially after 12 weeks of storage (14.2° Brix). The TSS of drinks stored in transparent, brown and green bottles increased from 13 to 13.9, 13.8 and 13.7° Brix respectively. The increase in TSS may be due to partial hydrolysis of complex carbohydrates to soluble sugars.

The reducing sugar content of those stored in refrigerator did not change but non-reducing sugar increased slightly (5.9 per cent). In other samples reducing sugars increased to the extent of 9 to 17 per cent. The samples kept in the carton and placed in the sun showed the highest change (17 per cent) followed by those filled in transparent bottles and kept in the sun (14.6 per cent). The increase in reducing sugar content of samples packed in brown bottles and in green bottles and kept in the sun was 14 per cent. Samples kept under the shade but stored in cartons, or filled in green, brown or transparent bottles showed slightly lower increase but reflected similar trends as the samples kept in the sun. Those kept in cartons had the highest increase of 11.4 per cent followed by transparent bottles (10.6 per cent), brown bottles (10.6 per cent) and green bottles (8.9 per cent).

Faster and greater changes in non-reducing sugar occurred in samples stored in sun than those stored in the shade. The effect of bottle colour and carton on non-reducing sugar showed a decrease.

Changes in ascorbic acid content of the drink: Samples kept in refrigerator did not undergo any change in ascorbic acid content (Table 1). Higher losses were observed in samples stored in sun than those stored in the laboratory. In all the bottles, irrespective of colour, ascorbic acid changes were rapid in the first two weeks of storage followed by a gradual decrease for the rest of the storage period. Soursop filled in transparent bottles and kept in the sun retained 30 per cent of its ascorbic acid while those filled in the same bottles but packed in the carton retained 60 per cent. The soursop drink samples filled in brown bottles and stored in the sun retained 43 per cent of their ascorbic acid content while those in green bottles retained 48 per cent of their

TABLE 1. CHANGES IN PH, ACIDITY, TOTAL SOLUBLE SOLIDS, SUGARS AND ASCORBIC ACID IN SOURSOP DRINK STORED FOR 12 WEEKS

Storage condition*	Acidity (as anhydrous citric) (%)		Total souble solids (%)	Reducing sugars (%)		Non-reducing sugars (%)			Ascorbic acid (mg/100ml)		% retention after 12 wk
	0 wk	12 wk	12 wk+	12 wk+	% change after 12 wk	0 wk	12 wk	% change after 12 wk	0 wk	12 wk	
Refrigerator	0.46	0.46	13.0	12.3	0.0	1.7	2.4	5.9	13.3	13.3	100
Transparent-shade	0.46	0.40	13.0	13.6	10.6	2.4	0.0	100.0	13.3	6.8	51
Green-shade	0.42	0.36	13.0	13.4	8.9	2.4	0.1	95.8	13.5	7.8	58
Brown-shade	0.42	0.36	13.0	13.6	10.6	2.4	0.7	71.0	13.5	7.3	54
Carton-shade	0.42	0.36	13.0	13.7	11.4	2.4	0.1	95.8	13.5	6.5	52
Transparent-sun	0.46	0.40	13.9	14.1	14.6	2.4	0.0	100.0	13.2	4.0	30
Green-sun	0.42	0.36	13.7	14.0	13.8	2.4	0.0	100.0	13.5	6.4	48
Brown-sun	0.42	0.36	13.8	14.0	13.8	2.4	0.0	100.0	13.5	5.8	43
Carton-sun	0.42	0.36	14.2	14.4	17.1	2.4	0.0	100.0	13.5	5.4	40

*Storage conditions are: Shade means storage on laboratory shelf; sun means storage under direct exposure to sun; and colour mentioned indicates colour of the bottle.

+Initial value for total soluble solids is 13.0% and reducing sugars is 12.3% in all the treatments.

TABLE 2. AVERAGE ORGANOLETPIC RATINGS OF SOURSOP DRINK

Sample*	Colour	Flavour	Taste	Consistency	Overall impression	Rank
Fresh drink	7	7	7	7	7	1
Refrigerated	7	7	7	7	7	1
Transparent-shade	6	6	5	6	6	4
Green-shade	6	7	6.7	6	6	2
Brown-shade	3	6	5.6	6	5	5
Carton-shade	6	6	5.6	6	6	3
Transparent-sun	3	3	2.3	3	3	7
Green-sun	4	3	3.4	3	3	6
Brown-sun	2	3	3	3	3	8
Carton-sun	2	3	3	1	1	9

*Storage conditions as under Table 1.

original ascorbic acid during three months storage period. The trend in the loss of ascorbic acid was similar for identical bottles kept in the shade—transparent bottles loosing the maximum (49 per cent), followed by the same bottles in the carton (48 per cent), brown 46 per cent) and green (42 per cent) bottles.

Organoleptic evaluation of the drink: The results of organoleptic evaluation by taste panel of a freshly prepared sample and samples held under different storage conditions for three months are presented in Table 2. Statistical analysis of the data was done using the Jonkhers Statistical Method[12].

The results of organoleptic analysis show that refrigerated storage is as good as the fresh drink (overall score 7). These samples are significantly different from those stored in the shade as well as those exposed to sun. The average score for the drink stored in shade is 6 except in samples filled in brown bottles where the overall score is 5. This shows that those kept at room temperature are very slightly different from the refrigerated samples in taste, colour, consistency and are very much acceptable to the panelists. Not withstanding statistical significance it is important to note that a score of 6 and 7 may be less significant in practical terms when applied to organoleptic evaluation[13].

From the above, it may be concluded that soursop drink should be stored under refrigeration for maximum nutrient retention and taste. Since this storage condition is not usually available in the marketing centres, such drinks should preferably be filled in green bottles and protected from the direct sun.

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Studies on the Physico-chemical Composition of Fruits of Twelve Papaya Varieties

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Twelve papaya varieties were examined for their physical characters like size, pulp colour, texture and density, fruit and seed cavity dimensions and chemical composition viz. T. S. S., acidity, drymatter, alcohol insoluble solids, starch, sucrose, glucose, fructose, minerals and vitamins. Wide variations in these constituents were observed. Varieties with desirable physical characters and high nutritional values are suggested as promising in terms of quality and their scope of utilization.

Papaya (*Carica papaya* L.) is an important source of vitamins and minerals in addition to papain. Under the papaya improvement programme of this Institute, a large number of indigenous and exotic varieties were introduced for evaluation. The practical utility of nutritional evaluation of germplasm in identifying superior genotypes has been reported in a number of fruits and vegetables.[1-4] The variations observed in the physico-chemical composition of fruits of twelve promising papaya varieties and the importance of such information in identifying varieties with superior nutritional quality for specific uses are discussed in this communication.

Materials and Methods

Fruits harvested from two-year old plants of twelve papaya varieties (Table 1) grown under the agro-climatic conditions of the experimental Station, Hessaraghatta, Bangalore were used for this study. When 1/3 of the skin colour turned yellow, the fruits were harvested and kept at room temperature for ripening. Physical characters such as pulp colour, hardness of fruit, average weight of single fruit, fruit density, proportion of peel, pulp and seeds, fruit and seed cavity dimensions were recorded by the accepted methods.[1-4] Dry matter, alcohol insoluble solids, starch, total and reducing sugars and vitamin C contents in edible pulp were estimated by standard AOAC methods.[5] β-carotene content was estimated using solvent extraction procedure of Dharkar *et al.*[6] and the values were converted to vitamin A units. Total soluble solids in juice was measured using Erma Refractometer at 20°C. Fructose was estimated by resorcinol-thiourea method.[7] Glucose values were obtained by subtracting fructose content from reducing sugars. The oven-dried samples were used for nitrogen estimation by micro-kjeldhal method and the values were multiplied by 6.25 to get crude protein. A known weight of oven -dried material was digested with tri-acid mixture, and the digested material was used for the estimation of phosphorus, potassium and calcium.[8,9]

Results and Discussion

The physico-chemical composition of fruits of twelve papaya varieties are presented in Table 1 and 2. On an average the fruits took 3 to 5 days after harvest to reach eating ripe stage under room temperature (27 ± 2°C) conditions. The variety 'Thailand' gave large sized fruits followed by 'Coorg Honey Dew'. The average fruit weight ranged from 0.48 to 1.92 kg. The pulp content ranged from 73.01 to 88.70 per cent. Besides the varietal differences, the seed content in papaya fruits depended on cropping season, and the type of pollination. The fruit density varied from 0.90 to 1.12. The pulp colour of varieties varied from pure yellow to pure pink. 'Pink Flesh Sweet' and 'Washington'had soft pulp. In other varieties it varied from medium soft to hard. The variety 'Thailand' had a few ridges on the tail end of the fruit; other varieties had no ridges. The length, breadth of fruit and seed cavity (cm) ranged from 8.8 to 28.6; 6.7 to 15.9; and 6.5 to 23.9 respectively whereas the seed cavity breadth was 5.0 to 7.5 cm. Desirable character for processing of papaya are large size, fewer or no ridges on the surface, small seed cavity and thick and firm flesh.[10] The variations observed in the physical characteristics suggests the existence of favourable size, pulp

Contribution No. 853.

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS OF PAPAYA FRUITS

Variety	Weight (kg)	Density	Length (cm)	Breadth (cm)	Pulp (%)	Peel (%)	Seed cavity Length (cm)	Seed cavity Breadth (cm)	Acidity (g citric acid/ 100g pulp)
Coorg Honey Dew	1.37	1.04	18.8	12.6	87.7	6.7	15.1	7.1	0.062
Pink Flesh Selfed	1.05	0.97	15.9	11.9	85.4	8.2	12.6	7.4	0.109
Pink Flesh Sweet	0.86	1.03	15.8	10.0	86.4	6.8	12.0	6.5	0.092
Solo Large Sweet Selfed	0.60	1.02	13.0	9.0	83.7	8.6	10.5	5.0	0.084
Solo Open Pollinated	0.65	1.08	8.8	6.7	73.0	9.2	6.5	5.4	0.089
Solo Small Open Pollinated	0.64	1.06	9.3	10.7	73.9	10.2	7.3	6.5	0.110
Solo Small Open Pollinated Sweet Medium	0.74	1.02	13.1	10.8	79.4	9.0	10.5	6.4	0.116
Solo Yellow Sweet Selfed	0.60	0.90	12.5	10.8	78.2	8.0	9.3	7.0	0.081
Sunrise Open Pollinated	0.65	0.91	13.8	10.8	82.4	7.5	11.8	6.8	0.096
Sunrise Selfed	0.48	1.08	10.0	8.7	82.5	7.9	7.7	5.8	0.089
Thailand	1.92	1.12	28.6	15.9	88.7	8.0	23.9	5.6	0.096
Washington	1.09	1.02	18.8	13.3	82.2	8.5	13.1	7.5	0.058

colour, texture and flesh thickness in papaya fruits.

The variety 'Coorg Honey Dew' recorded the highest T.S.S. (12.0 per cent) followed by 'Pink Flesh Sweet' (11.6 per cent). The open pollinated variety 'Solo Small' had lowest T.S.S. (7.2 per cent). High T.S.S. is a positive attribute for desert quality. As compared to other fruits, total titrable acidity was considerably low in papaya fruits. The open pollinated variety 'Solo Small' had maximum acidity and 'Washington' had minimum acidity. The T.S.S./acidity ratio ranged from 72 to 194.

Papaya fruits are reported to be good source of both vitamins A and C.[10] Vitamin A content calculated from β-carotene values ranged from 1600 to 6347 i.u. per cent. Vitamin C content ranged from 46.6 to 125.9 mg per cent. Varieties with high vitamin content could be used as one of the parents in breeding programme aimed at improving the nutritive value of papaya.

The study on the composition of sugars of different varieties revealed that considerable variability existed among the varieties. The range of values in per cent are, alcohol insolubles 2.0 to 3.4; starch 0.36 to 0.84; sucrose 0.48 to 2.47; glucose 2.91 to 5.24; fructose 2.34 to 4.19 and glucose/fructose ratio 0.73 to 1.81. Like other fruits, the palatability and taste in papaya are closely associated with the amount of sugars present.

TABLE 2. CHEMICAL COMPOSITION OF PAPAYA FRUITS

Variety	Vitamin A (I.U.) (%)	Vitamin C (mg%)	Sucrose (%)	Glucose (%)	Fructose (%)	Crude protein (%)	Phosphorus (mg%)	Potassium (mg%)	Calcium (mg%)
Coorg Honey Dew	3649	66.6	1.49	5.23	3.18	0.44	4.10	0.46	14.70
Pink Flesh Selfed	4715	82.2	1.41	3.13	4.16	0.52	5.06	0.60	14.40
Pink Flesh Sweet	3399	63.2	2.47	4.09	3.06	0.32	5.01	0.40	12.93
Solo Large Sweet Selfed	3749	93.8	1.10	4.35	3.00	0.38	4.06	0.40	8.03
Solo Open Polinated	6347	117.1	1.12	4.15	3.02	0.36	4.28	0.49	14.74
Solo Small Open Pollinated	5381	125.9	0.95	3.34	3.74	0.37	4.75	0.48	14.72
Solo Small Open Pollinated Sweet Medium	4965	91.7	0.99	2.91	3.26	0.34	4.40	0.47	21.04
Solo Yellow Sweet Selfed	5110	82.2	0.52	3.06	4.19	0.37	4.35	0.40	14.47
Sunrise Open pollinated	1600	46.3	0.48	4.16	3.71	0.49	4.45	0.36	11.40
Sunrise Selfed	1599	71.3	1.96	3.58	2.34	0.39	4.96	0.43	17.40
Thailand	2199	46.6	1.82	4.44	2.64	0.57	4.39	0.33	8.41
Washington	5115	78.1	1.81	5.24	2.90	0.34	7.04	0.63	12.03

Among the varieties, 'Pink Flesh Sweet' had the highest percentage of sucrose and fructose and the 'Coorg Honey Dew' registered maximum glucose content. The composition of sugars is of paramount importance in evaluating a variety for desert or for processing purposes. The analytical data compiled could provide useful guidelines for selecting a variety for specific processing purpose.

The concentration of dry matter ranged from 11.88 to 13.81 per cent; whereas the contents of minerals also showed much variation (Table 2). Varieties with maximum concentration of minerals are superior in their nutrititional quality. The desirable characteristics in papaya fruits are generally dictated by their intended use and hence the data presented are of practical utility in suggesting the scope of their utilisation.

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Effect of Heat Treatment on the Nutritive Value of Wheat Germ

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The PER of steamed germ was 2.84, which was significantly higher than that of raw (2.47), toasted (2.64) and drum dried (2.55) germ. The available lysine contents of the proteins of raw, toasted, steamed and drum dried germ were 5.71, 5.17, 5.61 and 5.40%, respectively. There was drastic reduction in the extractability of proteins in 5% potassium sulphate solution and a total destruction of trypsin inhibitor in both the steamed and drum dried germ. These findings indicate that processed wheat germ, which containes about 28% protein and 11% fat can be utilised as a nutritious food supplement.

The wide prevalance of protein and calorie malnutrition in many of the developing countries has been amply demonstrated[1]. Wheat germ, which is separated along with the bran, during the roller flour milling of wheat and used presently as cattle feed, appears to be a potential source of protein food for human consumption as it contains 25 to 30 per cent protein of excellent quality. In India, about 60,000 tonnes of wheat germ can be recovered annually, as a by-product of roller flour milling industry[2]. However, due to the high content of unsaturated fat and lipolytic enzymes it keeps only for 1-2 weeks. Laboratory studies were carried out earlier at this Institute for enhancing the keeping quality of wheat germ by heat processing methods[3]. However, a review of literature revealed contradicting findings with regards to the effect of different heat treatments on the nutritive value of wheat germ[4]. In this paper, the effect of different heat treatments on the nutritive value of the heat proceessed wheat germ is presented.

Materials and Methods

Samples of raw (unprocessed) commercial wheat germ were obtained from roller flour mills located in Calcutta, Bombay, Indore, Bangalore and Pondicherry. A commercial brand of unprocessed wheat germ packed under nitrogen was procured from U.S.A. and analysed

for comparison. Due to its extremely poor shelf-life, a wheat germ sample from a nearby flour mill was selected for detailed studies. The edible grade groundnut cake flour and skim milk powder were procured locally. The diets based on these were included in PER experiments for comparison. For exploring the scope of utilising drum dried germ as weaning food, a commercial brand of drum dried weaning food was included for comparison.

The purity, expressed as the percentage of flat and pale-yellow germ fraction in commercial samples was determined, in duplicate, by separating out manually, the bran and endosperm particles, using a magnifying glass.

The chemical composition of different wheat germ samples and the extractability of proteins in 5 per cent potassium sulphate solution were determined by AOAC methods[5]. The available lysine content was estimated according to Carpenter's method[6]. The trypsin inhibitor activity in these samples was determined according to the method of Kakade *et al*[7].

Heat treatments: Well mixed sample of germ was subjected to the following treatments[3]: (*a*) toasting a 2.5 cm thick layer of germ in an air circulation oven at 150°C for 20 min; (*b*) steaming a 5 cm thick layer of germ at atmospheric pressure for 10 min; and (*c*) drying a slurry containing 33 per cent of wheat germ or a blend of wheat germ and groundnut flour (80:20) on a double drum drier maintaining a steam pressure of 35 psig and drum speed of 3 rpm.

Protein efficiency ratio (PER): The PER of different heat treated germ samples of 85 per cent purity were determined at 10 per cent protein level by the method of PAG[8]. Seventy two male weanling rats (21 days old) of Wistar strain were distributed according to the randomised block design at the rate of 8 rats per group. The rats housed individually in wire mesh cages were fed weighed amounts of diets for four weeks and the increase in body weights as well as food intake were determined. The PER was calculated as the gain in weight per gram of protein consumed.

Results and Discussion

Chemical composition: Data on the chemical composition of different germ samples (Table 1) showed that the Indian samples compared favourably with USA sample. The variation in the protein contents of the germ samples ranging from 20.0 to 28.4 per cent may be attributed to the differences in their purity (42.8 to 94.1 per cent). Since the protein content of the pure germ does not vary much, it is necessary that the roller flour mills resort to appropriate milling techniques, so that the purity of the germ recovered is about 80 per cent. The protein content of such germ will be about 25 per cent and hence suitable for the enrichment of processed foods.

TABLE 1. PURITY AND PROXIMATE COMPOSITION OF COMMERCIAL GERM SAMPLES

Constituents	USA sample (%)	Experimental sample* (%)	Range** (%)
Purity	73.9	85.4	42.8 - 94.1
Moisture	10.8	8.8	7.3 - 13.6
Protein (N×5.7)	22.6	28.2	20.0 - 28.4
Fat	7.1	10.9	5.2 - 10.6
Ash	3.6	4.4	3.6 - 5.0
Crude fibre	3.4	3.2	2.2 - 6.7
Carbohydrates (by diff.)	52.5	44.5	39.9 - 52.8

*Used in the PER experiments

**Based on analysis of five commercial samples

Effect of heat processing on the available lysine and the solubility of proteins: It is well established that the available lysine and the extractability of proteins of processed foods decrease by heat treatment. Hence, the effects of different heat treatments employed to stabilise the germ on these important parameters were studied. The decrease in available lysine content of germ due to toasting, drum drying and steaming was 14.9, 8.8 and 1.3 per cent, respectively, on equimoisture basis (Table 2). Among the different treatments, toasting resulted in maximum loss of available lysine. These values are lower than those observed by Olsen[9] who reported a reduction in the available lysine content by 12, 16, 25 and 42 per cent in the toasted (at 121°C for 45 min) germ and the germ autoclaved at 15 psig for 20, 45 and 90 min, respectively. This showed that the heat

TABLE 2. EFFECT OF HEAT TREATMENT ON THE AVAILABLE LYSINE, SALT SOLUBLE PROTEINS AND TRYPSIN INHIBITOR ACTIVITY OF WHEAT GERM

Heat treatment method	Moisture (%)	Available lysine (g/100g protein)	Salt-soluble proteins*		Trypsin inhibitor	
			% of germ	% of germ proteins	Tyrosine released**	% inactivation
Nil (raw)	8.3	5.71	21.1	74.7	88	0
Toasting	2.4	5.17	16.9	60.0	214	45
Steaming	8.7	5.61	8.7	30.8	368	100
Drum drying	4.9	5.40	8.7	30.8	368	100

*Soluble in 5% solution of potassium sulphate

**Microgrammes of tyrosine released in 20 min at pH 7.6. Value for experimental blank without adding germ (source of inhibitor) was 368 microgrammes.

treatments employed in the present study, besides enhancing the shelf-life to more than 6 months[3] resulted in lesser heat damage to germ proteins.

As regards the effect of heat-treatments on the extractability of proteins in 5 per cent potassium sulphate, the data indicated that as compared to raw germ there was a 60 per cent decrease due to steaming and drum drying and 80 per cent by toasting of germ. This decrease in solubility is due to different degrees of denaturation of proteins during heat treatments/processing.

Trypsin inhibitor: The moist-heat treatments, namely steaming and drum drying, totally inactivated the trypsin inhibitor (Table 2). These results are similar to that reported by Moran *et al*[10], in autoclaved germ sample. On the other hand, toasting brought about only 45 per cent inactivation.

Protein efficiency ratio: Heat treatments of germ showed beneficial effect on the nutritive value, as indicated by the PER (Table 3). Steaming brought about a significant (at 5 per cent level) improvement in the PER (2.84) as compared to those of raw (2.47), toasted (2.64) and drum dried (2.55) germ. It has been reported that optimal heat treatment of vegetable proteins results in an increase in their digestibility and biological value[11]. On the other hand, Rand and Collins[12] have reported that severe heat treatment affects adversely the nutritive value of germ.

Though the raw germ has been reported to have a PER comparable to that of non-fat dried milk solids[13], the same had an appreciably low PER in the present study. This may possibly be attributed to the contamination of germ sample (of 85 per cent purity) with 15 per cent bran and endosperm.

It is interesting to note that inspite of replacing 20 per cent of germ with groundnut flour (having a low PER of 1.89), a drum dried product based on a 80:20 blend of germ and groundnut flour had a slightly higher PER (2.66) than that of drum dried germ alone (2.55) (Table 3). This may probably be attributed to the mutual amino acid supplementation. Further, the PER of this blend was equal to the commercial brand of weaning food (2.67), indicating the possibility of using drum-dried blend of germ and edible grade groundnut flour as weaning food. This blend had a protein content of about 32 per cent, as against 22 per cent in the commercial brand of weaning food.

The study showed that appropriate heat treatments of the commercial wheat germ improves its nutritive value considerably. Such processed germ can be used with advantage for the protein-enrichment of processed foods.

TABLE 3. EFFECT OF HEAT TREATMENT OR BLENDING WITH EDIBLE GROUNDNUT FLOUR ON THE PROTEIN EFFICIENCY RATIO* OF WHEAT GERM

Diets	Protein intake (g)	Wt. gain (g)	PER** 4 wk.	Corrected PER*
Raw germ	31.94	78.94	2.47^{a}	2.30
Toasted germ	33.82	89.62	2.64^{ab}	2.46
Steamed germ	32.03	91.19	2.84^{d}	2.65
Drum dried germ	31.57	80.62	2.55^{ab}	2.38
Drum dried blend (germ, 80+groundnut flour, 20)	32.26	85.75	2.66^{b}	2.48
Steamed germ, 20+groundnut flour, 80	25.50	50.94	1.99^{c}	1.85
Groundnut flour	23.98	45.38	1.89^{c}	1.76
Weaning food (commercial)	29.95	80.06	2.67^{b}	2.49
Skim milk powder	31.89	102.56	3.22^{e}	3.00
S. Em			±0.06	
Degrees of freedom			56	

Results of test of significance by Duncan's New Multiple Range Test at 5% level

*Mean values for 8 males per group (initial body weight-38.35-38.61 g) for diets containing 10% protein

**Means followed by different letters differ significantly

+Based on a value of 3.0, as standard for skim milk powder.

Acknowledgement

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Improvement of Baking Quality of Oilseed-Enriched Wheat Flour by Addition of Gluten and Soyalecithin

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Replacement of wheat flour in the dough with 5-10% defatted soyabean or peanut flour altered the rheological characteristics such as water absorption capacity and extensibility of the dough-mixes. These changes were reflected in baking qualities and breads prepared from these doughs had smaller loaf-volume and lower preference by test panelists. Addition of gluten (1.1%) partially corrected some of the rheological and baking properties, but acceptability of the bread was low. However, addition of soyalecithin (0.5%) improved sensory characteristics as well as acceptability of breads, supplemented even with 15% oilseed flours.

In most developing countries, *per capita* consumption of protein is below the recommended level which resulted in wide-spread protein-calorie malnutrition[1]. Cereals and starchy staples form 60 per cent of total protein intake for majority of these populations[2]. Consumption of animal protein is low because of its limited supply and high cost. Leavened bread is increasingly becoming a common cereal-based food, but the commercial bread contains only 8 per cent protein. The nutritive value of bread can be improved by supplementation with locally available high protein sources by raising protein content and balancing essential amino acids. The baking properties[4,5] and functional characteristics[6,7] of various oilseed flours including cottonseed, peanut, soyabean, sunflower, chickpeas, etc., as replacement for wheat flour have been investigated. Addition of non-wheat proteins at high levels, adversely affects the rheological properties and causes marked reduction in loaf-volume and poor acceptability of breads[8]. However, Khan *et al.*[9] have demonstrated that commercial defatted peanut and soya flour as well as peanut protein concentrates have excellent potential for use in bakery products upto 5-7 per cent levels. In recent years, small amounts of lipid surfactants or dough conditioners, such as sodium stearoyl-2-lactylate and calcium stearoyl-2- lactylate are used[10] to counteract the deleterious effects on the bread-making quality as a result of incorporation of non-wheat proteins in bread recipe. These are shown to accelerate the lipid binding during dough mixing[11] and to increase gas retention during fermentation[12], thereby improving loaf volume and organoleptic properties of high-protein breads. In the present study, an attempt has been made to incorporate optimum amounts of defatted soya and peanut flours into the dough, with minimum adverse affects on the organoleptic attributes of bread by incorporation of gluten or soyalecithin in the dough.

Materials and Methods

Red hard winter variety of imported wheat was procured from Food Corporation of India and milled into flour in a Buhler's laboratory mill at the extraction rate of 70 per cent. Soya bean was roasted, dehulled, ground (60 mesh) and extracted with n-hexane till completely free of lipids. Expeller pressed peanut flour was obtained from Tata Oil Mills, Bombay and crude soya-lecithin from Cadbury Fry Ltd., Bombay. Gluten was from Sigma Chemical Co., U.S.A.

Rheological properties: These were determined using various Brabender instruments as detailed earlier[13]. The dough development time, water absorption and mechanical tolerance index (MTI) were measured in a farinograph. The dough stability was recorded after a rest period of 60 min, followed by 5 min mixing. The dough extensibility and resistance to extention of the dough were evaluated from the extensogram.

Bread-making: Leavened breads were prepared according to straight dough lean formula[13] and 0.005 per cent $KBrO_3$ was incorporated. Water required to obtain optimum dough consistency of 500 B.U., was added. Wheat flour was replaced by equivalent amount of either defatted soya or peanut flour in bread mixes. In another baking test, gluten (1.1 per cent) was added to 10 per cent enriched formula, whereas 0.5 per cent soyalecithin (SL), (maximum limit permitted by FDA[14]), was incorporated in 15 per cent enriched dough. Crumb

compressibility or softness of freshly prepared bread was measured with 'Instron' Universal Texturometer (Table model) consisting of a moving cross head, driven synchronously at a number of set speeds. The slice (thickness 0.5 in.) was compressed at a constant force (2 kg). A stress-strain curve was recorded with a chart speed of 2 cm/min and the total area under the curve was measured by a planimeter. Loaf volume and crust colour were determined as described by Rao *et al.*[13]. Specific loaf volume was expressed as a ratio of loaf volume (cc) to loaf weight (*g*).

Sensory evaluation: Acceptability of breads was evaluated by a 12 member trained taste panel of the scientific staff. A modified triangular test with a 9 point numerical hedonic scale was used. Extremely liked sample scored 9 points and the sample not liked at all scored 1 point. The sample, scoring more than 5 points was judged as acceptable. Further, the detailed preferential opinions of the individual attributes of bread, namely, crust colour, taste, texture, flavour, etc., were sought from the panelist. Sensory characteristics were expressed in positive and negative terms. The percentage distribution of these preferences were calculated on the basis of 100 per cent score for non-enriched bread. Results were statistically analysed using Student's 't' test[15].

Results and Discussion

Rheological characteristics: Water absorption capacity, as evaluated from farinogram was increased by inclusion of 5-10 per cent soyabean flour in the dough (Table 1). This is in agreement with the results obtained by Tsen and Hoover[8], though Yousseff *et al.*[7] have observed about 1 per cent reduction in water absorption at high soya flour level. This value was much higher with peanut flour; 68 per cent water was required at 10 per cent replacement level to obtain peak dough consistency of 500 B.U. The addition of gluten had no effect in soya series, though 4 per cent increase in water absorption was recorded in the peanut series. Dough development time increased markedly with substitution of soya flour but did not change appreciably with peanut flour. Similarly, the known correlation between optimum water absorption and dough development time was not maintained in peanut series. When water required to obtain 500 B.U. on farinogram was added, the dough became very slack. The relaxation rate equalled the rate of dough development, and perhaps the dough was not developed. There was no significant difference in dough consistency or stability up to 10 per cent enrichment level. Further, addition of gluten did not show consistent effects and dough stability did not improve according to generally accepted considerations.

Similarly, evaluation of extensograms (Table 1) revealed that the energy required to stretch the dough to tearing point was much lower and dough extensibility was decreased after 135 min rest period, with increasing levels of oilseed flours. The ratio of height to width of the extensogram (ratio figure), which measures the strength of the dough, dropped from 6.6 for control to 5.5 for 10 per cent soya-enriched dough. Thus, weakening of dough consequent to soyabean or peanut flour supplementation could adversely affect the bread making qualities of these mixes. However, addition of 1.1 per cent gluten to 10 per cent soya or peanut flour enriched mixes improved the energy and ratio figure. MacRitchie[16] has also shown the possibility of improving the strength of weak dough by adding gluten.

Baking properties: Relationship between the content of oilseed flour in bread mixes and specific volume of breads prepared from them, are shown in Fig. 1. The

TABLE 1. EVALUATION OF DOUGH PROPERTIES OF BREAD MIXES

Bread mix	Farinogram properties				Extensogram evaluation	
	Water absorption (%)	Dough development time (min)	MTI (B.U.)	Dough stability (B.U.)	Energy (cm^2)	Ratio figure
Non-enriched	60±1.2	9	120	100	127	6.6±0.05
Soya flour enriched (%)						
5	60±1.5	9	80	120	89	5.8±0.07
10	61±1.6	12	60	80	80	5.5±0.08
10+1.1% gluten	61±1.2	10	120	60	106	7.0±0.08
Peanut flour enriched (%)						
5	64±1.5	8	80	120	94	6.1±0.08
10	68±1.5	8	80	120	65	6.1±0.08
10+1.1% gluten	71±1.5	9	100	100	118	7.0±0.06

Average of three experiments in duplicate

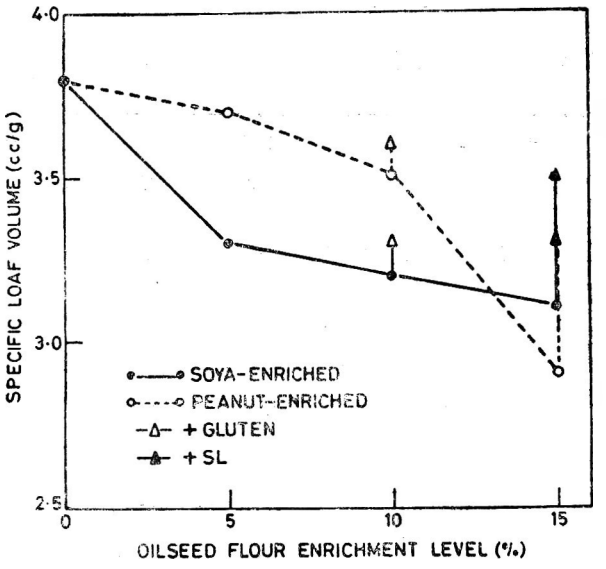

Fig. 1. Specific loaf volume of oilseed flour enriched bread.

volume was reduced by 16 and 9 per cent when wheat flour was substituted with 10 per cent soya and peanut flour, respectively. Soya proteins are shown to exhibit a strong binding power which resists dough expansion[17] and impair its gas retention capacity[18]. Addition of gluten also improved the loaf volume up to 10 per cent level of supplementation. Thus, supplementation with non-wheat flour altered the functional properties of the composite flour through dilution of gluten as well as partial replacement of wheat starch. Similarly, inclusion of soyalecithin increased the bread-volume considerably. Phospholipids, synthetic or natural glycolipids, are reported to impart beneficial effect on bread making quality of dough[19]. They are shown to accomodate soya protein in gluten matrix, thereby increasing the dough stability, presumably due to formation of stable lipoprotein complex[20]. This may overcome the adverse effects of soya flour and produce better breads.

Further, objective evaluation for softness or compressibility of breads containing 5 to 15 per cent of soya/peanut flour was carried out with Instron. The area under each peak of stress-strain curve (Fig. 2) revealed that non-enriched bread was very soft (49.3 cm^2), whereas breads, supplemented with oilseed flour at 15 per cent level were very firm and tough (85 to 94 cm^2). However, addition of 0.5 per cent soyalecithin improved the softness of these breads to a greater extent.

Sensory evaluation: Average scores of acceptability of breads on 9–point hedonic scale, based on paired preference testing, are given in Table 2. Enriched breads (at 10 per cent) scored lower compared to non-enriched ones, whereas at 15 per cent level, they scored just on or below the border line of acceptability (5 or less than

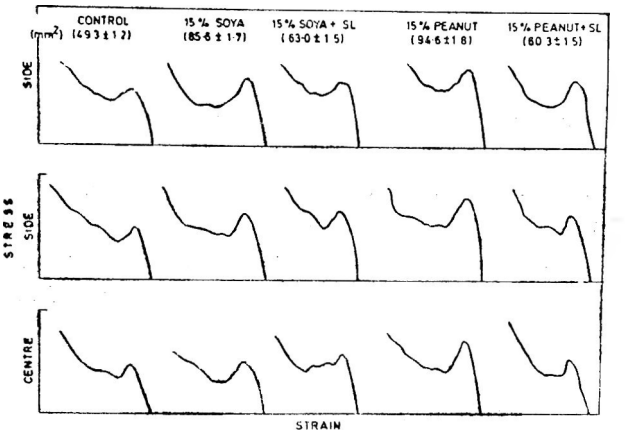

Fig. 2. Stress and strain curves of breads. Side slice from the side and Centre from the centre of the bread.

that). Inclusion of 1.1 per cent gluten slightly improved the acceptability of 10 per cent soya but not of peanut-enriched bread. However, addition of 0.5 per cent soyalecithin could restore the average score of these breads. Thus, a good correlation between the observations on the baking quality of the mixes was obtained when evaluated by objective (rheological) and subjective methods.

Sensory evaluation data (Table 3) revealed that peanut or soya enriched bread at 10 per cent, scored less for all the characteristics as compared to non-enriched one, though the preferences were very low at 10 per cent level. This could be attributed to dark crumb and crust colour as well as hard and brittle texture of the bread. Typical nutty flavour and bitter taste of peanut flour enriched bread also contributed to their significantly lower scoring. Though the addition of gluten (1.1 per

TABLE 2. SENSORY EVALUATION OF DEFATTED OILSEEDS FLOUR ENRICHED BREADS ON HEDONIC SCALE

Enriched bread mix	Average score
Non-enriched	7.16±0.37
10% soya flour	6.50±0.22
10% peanut flour	6.33±0.43
10% soya flour+gluten (1.1%)	6.80±0.32
10% peanut flour+gluten (1.1%)	5.66±0.40*
15% soya flour	5.83±0.36*
15% peanut flour	4.91±0.14*
15% soya flour+soyalecithin	7.05±0.30*
15% peanut flour+soyalecithin	6.91±0.31*

Results are averages of points on hedonic scale (±SE).
Range of scoring was from 1-dislike extremely to 9-like extremely
*$P \leq 0.01$

TABLE 3. DISTRIBUTION OF PREFERENCE TEST (PER CENT) FOR ENRICHED BREADS

Characteristics	Attributes		Peanut enriched (%) 10		15		Soya enriched (%) 10		15	
	Positive	Negative	-gluten	+gluten	-SL	+SL	-gluten	+gluten	-SL	+SL
Bread volume crust	Large even	Small uneven	63	82	50	82	82	90	72	90
Crust colour	Light	Dark	70	80	70	90	60	90	70	90
Crumb texture	Soft & spongy	Hard & non-spongy	82	63	45	72	82	72	63	72
Cell structure	Even uniform	Uneven non-uniform	82	82	54	63	90	82	63	72
Flavour	Pleasant	—	90	80	80	100	80	100	70	90
Taste	Normal	—	80	70	60	80	90	70	60	80

Averages of 3 panel tests comprising of 12 members each. Percentage preference as compared to non-enriched bread.

cent) to bread mixes improved the loaf volume, it contributed a hard and porous texture to the crumb and scored less in peanut supplemented bread (Table 2). Thus, different parameters (Table 3) did not have equal weightage in deciding the overall acceptability. The lower acceptability at 10 or 15 per cent (Table 2) could be attributed to undesirable negative characteristics (Table 3) such as uneven and dark colour of the crust, hard crumb, non-uniform cell structure, flat flavour and bitter taste. Addition of soyalecithin improved loaf-volume, crumb structure (Fig. 2) and acceptability of breads containing even up to 15 per cent level of oilseed flours Beneficial effect of the surfactant is attributed to its emulsifying properties[11]. It is also reported that addition of surfactant helps to retain softness and delay staling of bread[21]. However, the functional properties of soyalecithin in bread making are not well understood.

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Application of Pressure Parboiling Process for the Production of Bulgur Wheat

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A simple, quick and less costly method of production of bulgur wheat by pressure parboiling on large scale has been developed. The product is of acceptable quality for use in the midday meal programme for school children and for preparing dishes. The cost of bulgur wheat production employing this technique has been worked out.

At present 2.5 lakh tonnes of bulgur wheat is being used in the country. This is being mainly imported for the production of balahar. This paper reports the application of pressure parboiling technique developed earlier for parboiling of paddy[1] for the production of bulgur wheat.

Materials and Methods

The Australian Durum Wheat and the 'Kalyan' variety of the Indian hard winter wheat were processed in a vessel of 1.5 t capacity. The vessel consisted of a cylindrical steel tank with a dome shaped hood and bell bottom containing a perforated steel plate placed 20 cm above the bottom of the tank to keep the grain. Coils for passing steam are provided at the bottom, just below the perforated sheet. The vessel is steam jacketed and is provided with a steam controlling valve, a pressure gauge, a temperature gauge as well as water inlet (Fig. 1).

The vessel is half filled with water and the uncleaned raw wheat is fed in a thin stream, so that the lighter foreign materials and chaff would float which can be skimmed off by draining through the top drain valve. The water is circulated for about 5 min to replace the air in the intergranular space and then the water is drained and the heavier foreign matter like mud and sand are carried off through the bottom drainage valve. Inlet steam at a pressure of 12.5 kg/cm^2 is passed for 10 min which is the time required for steam to occupy and to replace the intergranular air. The wheat is then open steamed for 10 and 15 min for 'Kalyan' and Australian durum wheat varieties respectively. During open steaming the steam exhaust valve is half closed to minimise steam wastage and to avoid building up of pressure inside the vessel.

On completion of open steaming, the steam outlet valve is closed and the pressure is increased to 1.4 kg/cm^2; the time required for this is 5 min. This pressure is maintained for 25 min for 'Kalyan' variety and 20 min for Australian durum wheat. This completes the bulgurisation process. The wheat is then discharged. The

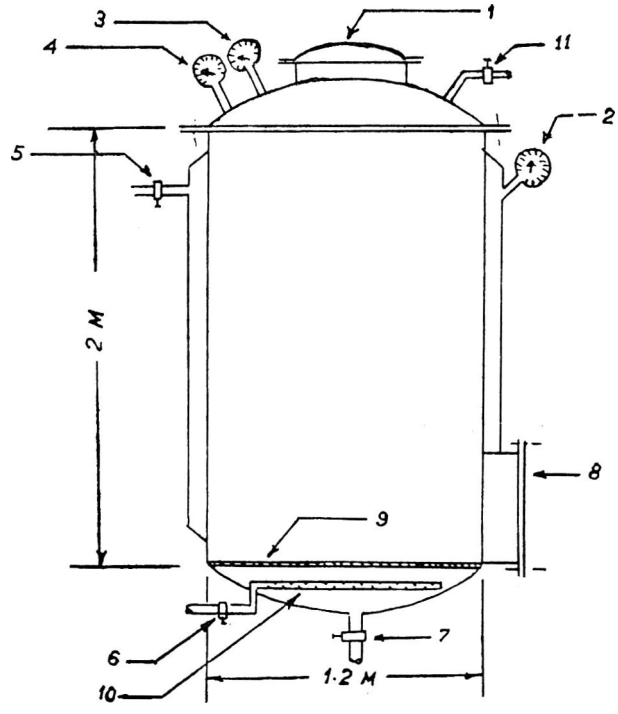

Fig. 1. Baby Extractor

1. Feeding door; 2. Pressure gauge (range O° to 50 PSI) for jacket; 3. Pressure gauge (range O to 100 PSI) for processing chamber 4. Vacuum gauge; 5. Steam inlet valve to jacket; 6. Steam inlet valve to coil under the material; 7. Circulation & drain valve; 8. Discharge door; 9. Filter; 10. Steam coil; 11. Steam outlet valve.

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whole steaming process needs 55 min. The wheat after discharge is heaped for 2 hr for tempering and equilibriation of moisture.

Twelve batches of 1.25 t each, were processed and sun-dried. The dried wheat (moisture content 12.5 to 14.0 per cent) was polished to 5.8 per cent in Kyowa and Schule rice polishers and in paddy hullers. The polishing in the huller was done by adding 5 per cent of paddy husk. The polished wheat was broken in a grinder to a maximum yield of large brokens (1/4 the size of whole wheat) required for Balahar preparation. The broken wheat was sieved through 10, 20 and 30 sieves of Indian Standards Institution specification.

Results and Discussion

During open steaming the grains absorb moisture and swell. The final moisture content of the product obtained by this method was much lower than the moisture in the product obtained by the conventional method of soaking in water for 12 hr followed by open steaming for 15 to 20 min[2].

The moisture content at the time of discharge was 28-30 per cent as against 60 per cent in wheat bulgurized by cold soaking and steaming. Heaping the steamed wheat for 2 hr, helped in conditioning the wheat. Moisture content of wheat at different stages of parboiling is given in Table 1.

Polishing with 5 per cent rice husk in a rice huller was better than polishing in the Kyowa rice polisher. Polishing in Schule rice polisher also did not give satisfactory results.

Milling of wheat for different size fractions was accomplished by 30 cm plate type flour mill (grinder) with suitable adjustments. The large brokens that passed through 10 mesh and those retained on 20 mesh were separated and these were found suitable for Balahar production.

The particles passing through 20 mesh and those retained on 30 mesh were of the size of Suji (wheat grits) and could be used for preparing *Uppumao* and *Halva* (a sweet meet preparation). The very fine particles passing through 30 mesh were further sieved to separate the bran particles. These fine particles could be used for preparing *Kheer*. The physical analysis of broken bulgur wheat is given in Table 2. All the above preparations were made in the laboratory and their quality was found satisfactory in the midday feeding programme for children.

TABLE 1. MOISTURE CONTENT OF WHEAT AT DIFFERENT STAGES OF PARBOILING

Particulars	Moisture content (%)
Raw	14.50
After steaming (at discharge)	27.8 – 28.0
After 2 hr (conditioning)	26.8 – 27.1
After drying (before polishing)	12.5 – 14.0

TABLE 2. PHYSICAL ANALYSIS OF BROKEN BULGUR WHEAT

Mesh size	Brokens retained on sieve (%)
ISI mesh No. 10	47
ISI mesh No. 20	47
ISI mesh No. 30	5.5
Retained on receiver	0.5

A total of 15 t of wheat were processed by the above method and the nutritional quality and palatability of various dishes were evaluated in Avinashilingam Home Science College, Coimbatore, SIET College, Madras and Food & Nutrition Board laboratories at Madras and Delhi. They all certified that the product was fit for use in Balahar. The results of chemical analysis of raw and Bulgur wheat are given in Table 3.

Costing of the process (1.25 *t of raw wheat per batch*):

1.	Labour charges at Rs. 2/tonne for loading	Rs. 2.50
2.	Cost of 3000 l of water including pumping	Rs. 0.50
3.	Unloading	Rs. 2.50
4.	Cost of steam (200 kg/batch) (using oil fired Lancashire boiler)	Rs. 15.00
5.	Helper at Rs. 5 per diem (3 batches/shift)	Rs. 1.66
	Total cost of bulgurizing 1.25t of wheat	Rs. 22.16
	Cost of bulgurizing 1 t of wheat	Rs. 17.72

The total cost of drying for two days was Rs. 7 per tonne including direct and indirect wages and expenses like depreciation and such other charges. Thus the total cost of processing including drying is approximately Rs. 24.72 per tonne. Experiments were carried out using 150-kg lots at pilot plant scale, for pressure parboiling without use of boiler. The product was comparable in quality to that produced in Baby Batch Extractor.

Bulgurization time can be reduced considerably by this process. The maximum time taken for the operation is only 55-60 min. As soaking is completely avoided and only vapour phase penetration of moisture is adopted, the leaching losses during soaking and cooking are also avoided.

The moisture content of wheat at the time of discharge

TABLE 3. CHEMICAL ANALYSIS OF RAW AND BULGUR WHEAT

Component	Raw wheat	Bulugr wheat			Max limit for standard
		Sample 1	Sample 2	Sample 3	
Moisture (%)	14.50	13.60	11.40	10.70	10.00
Ash (%)	1.53	1.36	1.58	1.57	3.30
Ash insol in HCl (%)	0.22	0.14	0.11	0.08	0.20
Crude fiber (%)	2.10	1.90	1.23	1.36	3.75
Crude protein (%)	11.34	11.62	12.52	11.95	16.21

is 28-30 per cent. The entrapped heat at the time of discharge was high. This heat facilitates faster drying. The initial low moisture content reduces the cost of mechanical drying. If the vacuum drying device provided in Baby Extractor is used, the time of drying can be reduced by 50 per cent.

The cost of operation and installation are also much lower compared to other processes.

Nutritionally the product compares favourably with the bulgur wheat currently being used in Balahar preparation.

During the cyclone in Tanjore District in November 1977 a large quantity of wheat stored under open storage condition was subjected to high humid weather which resulted in heavy fungal spoilage. Experiments were conducted to see whether pressure bulgurisation would destroy mycotoxins in such wheat. Representative samples from some of the fungus attacked consignments were subjected to pressure bulgurisation treatment. The samples were tested for mycotoxins at the National Institute of Nutrition, Hyderabad. All the ten samples of pressure bulgurised wheat were found to be totally free from all mycotoxins, while the control samples showed mycotoxin contamination. This finding indicates an interesting new venue of use for pressure bulgurisation. At present a major portion of wheat spoiled by fungal attack is used mainly as cattle feed or as manure. Even if it is used mainly as cattle feed, the pressure bulgurised wheat is safer because most of the mycotoxins are destroyed and hence do not find their way to the milk.

The bulgur wheat imported for use in the midday school feeding programmes costs nearly Rs. 1.5 crores per annum, though at present it is received as a gift. In case this gift is stopped, bulgur wheat may have to be imported. The production of indigenous bulgur wheat would curtail this import. It can also be exported to West Asian and East European countries, as India is a major producer of wheat. The bulgur wheat is quite acceptable in the rice consuming regions of India. Bulgur wheat whether broken or whole, can be used in a number of preparations popular with rice consumers. It can be produced in wheat growing areas making use of rice mills which have already adopted the pressure parboiling process.

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Characteristics and Composition of Indian Cassava Seed and Oil*

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A local variety of cassava (*Manihot esculenta* Crantz, *M. utilissima* Pohl) gave seed yield of 400 kg/ha. Seed contained 26% orange-yellow coloured oil and 18.5% protein. The oil has low unsaponifiable matter and the following fatty acid composition (weight %) as determined by gas-liquid chromatography: 8:0, 0.5; 10:0, 0.8; 12:0, 4.6; 14:0, 1.5; 16:0, 11.4; 18:0, 4.6; 18:1, 25.1 and 18:2, 51.4.

Although cassava (*Manihot esculenta* Crantz, syn *M. utilissima* Pohl) tubers form a major staple food in several developing countries, the seeds have not attained any nutritional or economic value. It was reported[1,2] that kernels of cassava seed produced in Ghana contain 47 per cent of lipids and 34 per cent of proteins. No attempts have been so far made to produce seeds from the plant as only the non-flowering and non-branching varieties are hitherto held suitable for good tuber yield. But there are indications that nontopping of inflorescence and seed setting does not affect tuber yield. Attempts are, therefore, made to grow the flowering variety of cassava, allow the inflorescence to set seed and characterise the seed and oil.

Materials and Methods

One of the local varieties of cassava grown in a 0.2 hectare plot in Tanjavur district started flowering in the sixth month and capsules appeared by eighth month. Second, third and fourth harvests were carried out in tenth and elventh months. In the twelfth month, the yields of tuber and seeds were assessed.

The seeds were stored at ambient temperature. The cleaned seeds were crushed in a country press (*ghani*) and the oil was filtered. The seeds were also pressed in a laboratory model Carver hydraulic press. The seeds, kernels, hulls and oil were analysed for their characteristics by AOCS methods[3]. The hydraulic pressed oil was refined and bleached in the AOCS Combined Refining and Bleaching Apparatus. Alkali lye of 15 Be' 60 per cent excess was used for refining. For bleaching, 2 per cent earth and 0.2 per cent carbon were used.

Methyl esters were prepared by refluxing liberated fatty acids (1.5 g) in methanol containing sulphuric acid. GLC of the methyl esters was carried out on both a polyester (10 per cent EGSS-X on Gas Chrom Q 80-100 mesh) column (2.4 m×0.32 cm) and a non-polar (5 per cent SE-30 on Chromosorb P 45-60 mesh) column (1.2 m×0.32 cm) under programmed temperature between 110° and 195°C (60°/min) using a Toshniwal gas chromatograph fitted with a flame ionization detector. The flow rate of the carrier gas, nitrogen, was 40 ml/min. Methyl heptadecanoate was used as the internal standard.

Results and Discussion

In the experimental crop, the seed setting was 75 per cent. Each plant gave 130 to 170 seed capsules, each capsule containing 3 seeds. The yield of seed was 400 kg/ha. There would be a potential of 0.15 million metric

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TABLE 1. CHARACTERISTICS AND COMPOSITION OF INDIAN CASSAVA SEED

	Seed	Kernel	Hulls
Wt. of 100 seeds (g)	10	—	—
Hull to kernel ratio	50:50	—	—
Moisture, (%)	4.6	—	—
Oil, (%)	26.1	49.0	3.0
Crude protein, (%)	18.5	29.2	7.6
Crude fibre, (%)	31.3	2.2	60.0
Total ash, (%)	7.2	4.0	10.6

tonnes of seed with a potential of 40,000 metric tonnes of oil in India. The tuber yield in the present case was 25 t/ha compared to a normal yield of 17.5 t/ha.

Cassava seed resembles castor seed with length, 10 mm; width, 6 mm; and thickness 4 mm. Table 1 gives characteristics of the seed. The hull (shell) content is 50 per cent which is higher as compared to 43 per cent in the seed produced in Ghana[2]. High contents of oil (49 per cent) and protein (29.2 per cent) and low content of crude fibre (2.2 per cent) in kernels indicate a good potential for edible uses. The hulls containing 7.6 per cent protein and high crude fibre (60 per cent) can possibly find use in animal feed compositions. Whole seed could be stored for one year. The free fatty acid content of oil in the seed during storage for one year rose from 3 to 3.9 per cent. There was no apparent effect on oil content of seed during storage. The whole seed yielded 12 per cent oil on crushing in a country press (village *ghani*) and 11 per cent oil in hydraulic press. The oil resembles some of the common edible oils such as sesame, maize germ and sunflower oils (Table 2).

The kernel lipids were reported[1] to contain 98 per cent triglycerides, the rest being composed of phospholipids,

TABLE 2. PHYSICAL AND CHEMICAL CHARACTERISTICS OF CASSAVA SEED OIL

Refractive index at 40°C	1.465
Specific gravity, 30/30°C	0.917
Colour	Orange yellow
Free fatty acid, (%)	2.5
Iodine value (Wijs)	115
Saponification value	200
Unsaponifiable matter, (%)	1.0
Reichert-Meissl value	1.2
Polenske value	0.8

TABLE 3. FATTY ACID COMPOSITION OF CASSAVA SEED OIL

Fatty acids	Present work (wt %)	Reported[1] (wt %)
Caprylic	0.5	—
Capric	0.8	—
Lauric	4.6	—
Myristic	1.5	0.07
Palmitic	11.4	10.34
Palmitoleic	—	0.09
Stearic	4.6	4.10
Oleic	25.1	22.40
Linoleic	51.4	61.60
Linolenic	—	1.40

glycolipids and steriods. The hydraulic pressed oil could be easily refined (refining loss 6.5 per cent) and bleached by standard methods. Raw oil with 2 per cent free fatty acid content and Lovibond colour (2.54 cm cell) of 11 Yellow and 1.4 Red gave refined oil of 0.2 per cent free fatty acid content and Lovibond colour of 1 Yellow and 0.1 Red. Potato chips fried in refined cassava seed oil were crisp and were comparable in taste to those fried in raw groundnut oil.

The fatty acid composition as determined by GLC on EGSS-X column is given in Table 3. The composition by chain length agreed well with that obtained on SE-30 column. The oil contains small quantities of C_8 to C_{12} saturated acids while the seed oil from Ghana contains trace quantities of palmitoleic and linolenic acids. Linoleic acid is present in a lesser concentration in the Indian sample (51.4 per cent) than in the Ghana sample (61.6 per cent)[1].

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Piperine and Related Compounds in Pepper I. Search for Minor Components

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Solvent fractionation, crystallization of pepper oleoresin and pungency evaluation by threshold methods has indicated that mother liquor has compounds other than piperine. Further study with argentation-TLC showed the presence of a compound which has only a fourth of the pungency of piperine. The coloured compounds in a total extract of pepper contribute 3 to 5% to the absorption at 342 nm. It has also been shown that spectrophotometric method could be conveniently used on a single corn of pepper.

Piperine, the 5-(3,4-dioxymethylenephenyl)-2-*trans*, 4-*trans*-pentadienoic piperidide is now recognized as the major pungency stimuli of pepper. Due to the very poor solubility of piperine in water and apparent lack of pungency of crystalline piperine, there has been continuous search for other related compounds in pepper which are strongly pungent. The stereoisomers of piperine have been intensely looked for, particularly in view of earlier claims of the presence of highly pungent 2-*cis*, 4-*cis* isomer. They, however, have not been identified in natural pepper with modern techniques of thin-layer and high pressure liquid chromatography[1,2]. Other related minor compounds that have been isolated and identified are piperettine, the 2, 4, 6-heptenoic analog[3]; piperanine, the 2-*trans* pentenoic analog[4] and piperylin (pyrroperine). the pyrollidine analog[1,5].

In quality evaluation, the importance of these compounds are related to their function as pungency stimuli. The pungency response of piperettine has not been recorded and of other compounds are either not rigorously established or reported to vary greatly[1,5,6]. From the absorption maxima of the identified compounds in pepper, it is clear that according to the Official Method of measuring absorption of diluted extracts at 342 nm will measure piperine and piperylin. A substantial part of piperettine will also be measured which though has its absorption maxima at 364 nm exhibit significant absorption at 342 nm. Piperanine, which has maximum absorption at 280 nm will not be measured at 342 nm.

It, therefore, appeared worth re-examining pepper extracts for minor components and their effect on the pungency of pepper. This problem was studied by *i*) trying to concentrate the minor components in the mother liquors by solvent fractionation and repeated crystallization of piperine; and *ii*) by argentation thin-layer chromatography which has been effectively used to separate isomers and closely related compounds varying in unsaturation.[7]

Materials and Methods

Fresh pepper oleoresin (150 g) was fractionated by successive extractions with hexane and ether.

Several samples of pepper, horticultural varieties, trade types and a sample from Ceylon were used. Freshly powdered pepper was extracted with ethylenedichloride, filtered and solvent removed under reduced pressure. A 10 per cent solution of the pepper extracts in ethyl acetate was made as stock solution.

Spectrophotometry: A Beckman recording spectrophotometer (DK-2) was used to record the spectra of suitably diluted solutions of the oleoresin, isolated piperine and related compounds and mother liquors. Analytical grade benzene was used for the dilution before spectrophotometry. Special care was taken to protect the solution at high dilution against light[6].

Thin-layer chromatography (TLC): Silica gel G (E. Merck) plates, 250μ thick for analytical work and 500μ thick for preparative separations were used after activation at 120°C for 1 hr.

For argentation-TLC, the silica gel suspension was made in 10 per cent silver nitrate and the plates activated as mentioned above.

Solvent system for TLC: (*i*) n-hexane: ethyl aceteate, (85:15, v/v), double development: (*ii*) ether:n-hexane, (5:1, v/v)[8]; (*iii*) ethyl acetate: carbontetrachloride, (1:1, v/v)[5]; (*iv*) ethyl acetate: dimethyl formamide,

(90:10 v/v), saturated with 3 ml of 20 per cent sodium hydroxide solution.

Determination of piperine and related compounds: Identity of piperine was made through R_f of co-chromatographed pure piperine (m.p. 128°C), visualized by 2, 4-dinitrophenylhydrazine (2, 4-DNPH) spray, chromic acid spray and by typical spectra of compounds extracted from corresponding area of co-chromatographed samples. The quantitative estimation of piperine and related compounds in the experimental samples, the total extracts, mother liquor, crystals and TLC isolated pieprine and related compounds was done by their absorption at 342 nm, using a standard curve for pure piperine.

Pungency determination: Pungency of the TLC separated areas corresponding to the coloured spots on a co-chromatographed spots were tasted directly as a confirmatory test or extracted with ether and diluted for estimation of pungency. Pungency of different fractions of the oleoresin or extracts were evaluated by standardized dilution technique for recognition threshold for pungency using a trained panel[9]. The panel recorded a pungency of 100×10^3 Scoville unit (SU) for pure piperine.

Results and Discussion

The first attempt to concentrate the piperine homologs was based on earlier observations on solubility in solvents of different polarity of the components in the pepper oleoresins and the ease of crystallization of piperine from ether solutions. Piperine and related compounds being insoluble in petroleum ether in cold, the oleoresin was exhaustively extracted with this solvent yielding a filtrate rich in essential oil components, the green colouring matter and fat. This fraction after removal of solvent gave nearly a third of the initial weight and contained 11 per cent equivalent of piperine. This was further fractionated by extraction with 60 per cent alcohol to separate the fat as a residue and coloured compounds in the extract. The piperine in the total hexane extract was concentrated in this residue because of its solubility in the fat.

The hexane insoluble main residue was attempted to be fractionated by extraction with ether at 0°C and at refluxing temperatures and piperine crystallized by refrigeration, hoping to enrich the piperettine in the mother liquors. The yield, spectral characteristics and pungency of all the fractions are given in Table 1 and spectra of selected fractions shown in Fig. 1.

All fractions except the coloured concentrate showed typical absorption pattern of piperine with the 342 nm maxima and the shoulder at 309 nm. However, the early fractions I to IV differed in the absorption at lower wave lengths and the ratio of absorption at 342 to 360 nm and 342 to 309 nm showed marked differences. All crystals and mother liquors from soxhlet ether extractions, Fractions IV to IX, gave typical ratios for 342 to 360 nm and 342 to 309 nm of 1.4-1.6, similar to that of pure piperine. The fractions of cold ether extracts gave low values for the ratio 342 to 360 nm while frac-

TABLE 1. YIELD, SPECIAL CHARACTERISTICS AND SCOVILLE HEAT VALUES (SU) OF PEPPER OLEORESIN FRACTIONS

Fraction No.	Yield (g)	Piperine* (%)	Ratio of 342nm/360nm	Ratio of 342nm/309nm	Pungency of fraction in SU × 10^3
I. Hexane extract	49	11	1.16	1.32	10
Residue, Ether Extracts					
II. Mother liquor—1st crystallization	31	42	1.20	1.46	40
III. Mother liquor—2nd crystallization	20	42	1.25	1.56	45
IV. Crystals	18	100	1.43	1.57	—
Soxhlet Extraction with Ether					
V. Crystals, 5 hr extract	9	103	1.45	1.60	100
VI. Mother liquor, 5 hr extract	6	75	1.32	1.59	—
VII. Crystals, 11 hr extract	2	103	1.48	1.57	100
VIII. Mother liquor, 11 hr extract	5	75	1.41	1.49	—
IX, Ether insolubles after 11 hr extraction	10	—	1.50	1.50	—
Oleoresin	150	53	1.36	1.69	60
Pure piperine	—	—	1.50	1.50	100

*The piperine content was calculated from 342 nm absorption

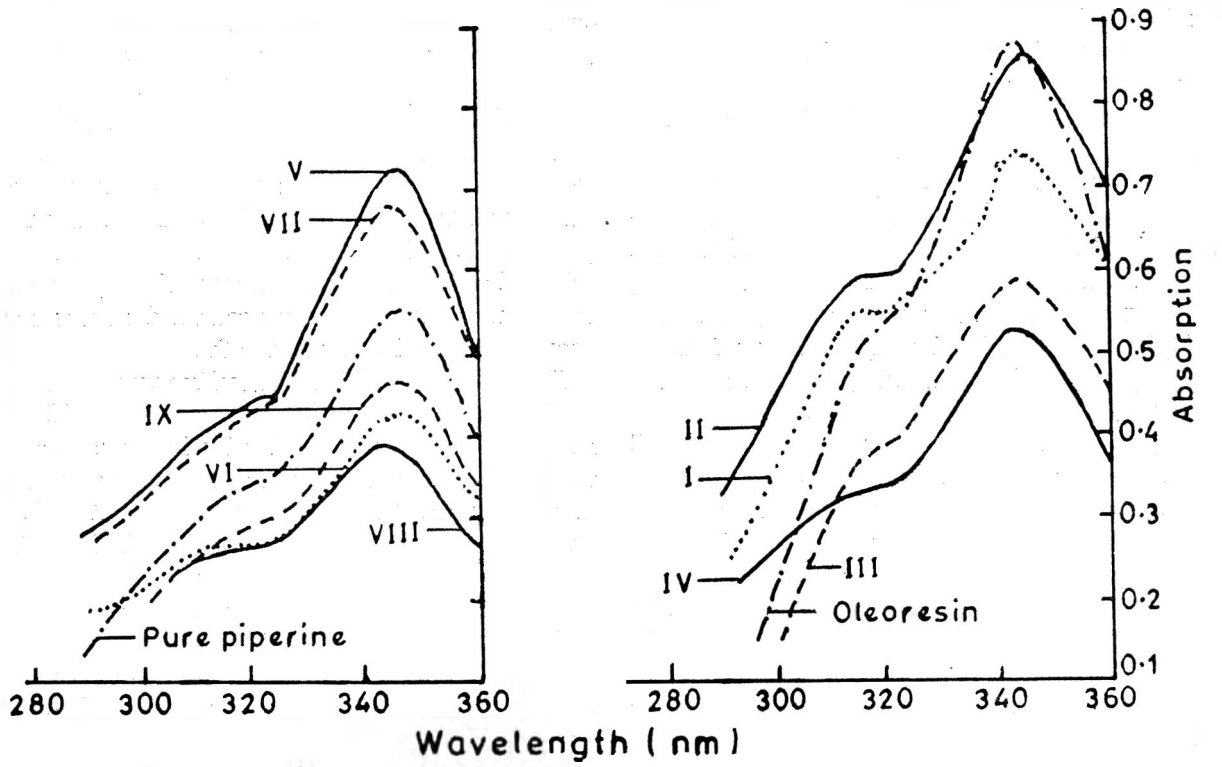

Fig. 1. Spectra of solvent fractionations of pepper oleoresin. Numbers correspond to fractions listed in Table 1.

tions of hexane extracts gave low ratios at both the pairs of wavelengths. The higher values for absorption at 360 and 309 nm of some of the fractions possibly showed contamination of piperine with other related compounds earlier reported as piperettine and piperyline. However, the pungency values (Table 1) of all the fractions, both hexane and ether soluble components, agreed with the expected value from the absorption at 342 nm calculated as piperine and using Scoville value of 100×10^3 SU for pure piperine. The recovery of piperine was complete, calculated on the basis of 342 nm absorption of all the fractions, though the recovery as crystals was only about 50 per cent.

It is interesting to compare these results with the fractionation of pepper oleoresin by molecular distillation by Tausig *et al*[6]. They found that for all the distilled fractions the UV spectrophotometric estimation of piperine and pungency in Scoville Units were correlated. The pot residue alone showed only half the value for pungency expected from the spectrophotometric piperine value. An absorption curve for this residue showed a broad plateau between 340 and 360 nm and related to the earlier work of Spring and Stark[3]. The authors speculated that half the absorption measured at 342 nm was possibly due to piperettine. However, the pungency of piperettine had not been established.

Isolation and estimation of piperine and related components: Separation of piperine and related components from essential oil, colour and wax was achieved by TLC using solvent system (i). The TLC separated essential oil compents at R_f 0.3 and above, identified by vanillin-H_2SO_4 on a co-chromatographed spot, did not show any absorption in the UV region of 360 to 280 nm. The coloured compounds remaining at the starting point showed a continuously raising curve. Its absorption at 342 nm for a number of samples showed that it contributed 3 to 5 per cent of the total absorption of the extract. Table 2 gives the values of the total piperine and related compounds along with the contribution of coloured compounds calculated from their 342 nm absorption as piperine. The values for piperine and related compounds after TLC separation are lower than the values obtained by direct UV on oleoresin because of the removal of the contribution of colour to 342 nm value and the recovery through TLC was 95-96 per cent as determined with pure piperine. The necessary correction factor for the lower recovery has been applied to the values for piperine and the related compounds shown in Table 2.

The molar extinction coefficient (ε) for piperine has been reported[1] to be as high as 32,000-37,000. The possibility of using this method as a micromethod which will be useful for genetic studies for the estimation

TABLE 2. PIPERINE AND RELATED COMPOUNDS ESTIMATED BY BY DIRECT UV AND TLC-UV OF EXTRACTS OF HORTICULTURAL AND TRADE TYPES OF PEPPER

Sample	Piperine content (%) as measured at 342 nm		
	Direct UV method	TLC UV method	Pigment TLC-UV method
Panniyur (Early maturity)	5.50	5.20	0.25
Panniyur (Optimum maturity)	5.03	4.60	0.34
Panniyur (Late maturity)	3.35	3.18	0.15
Balankotta	4.14	3.81	0.29
Kuthiravally	5.10	4.70	0.32
Ceylon	7.22	6.90	0.21
Garbled pepper	4.20	4.05	0.09
Light pepper	5.41	5.20	0.19
Pinhead pepper	1.05	1.00	0.09

of piperine and related compounds on a single corn of pepper (optimum maturity-'Panniyur') was examined. Even though there is a variation in piperine content from corn to corn (4.89 to 5.21 per cent by direct UV method; 4.61 to 4.82 per cent by TLC-UV method), it is comparable to the values obtained from the bulk samples as given in Table 2.

Argentation-TLC separation: The fractionation by solvents having failed to show any concentration of the minor components in any fraction but only gave an indication of the presence of homologs in early fractions. Separation was tried using argentation-TLC. Since non-polar solvents gave very little movement of piperine compounds, more polar solvents such as solvent (iv) were used. Dimethyl formamide in alkaline condition has shown some promise in the separation of piperine and dihydropiperine[4]. Fig. 2 shows the spectra of three spots obtained after argentation-TLC separation and the R_f values of these spots are given in Table 3. Even this close separation could be obtained not directly with the oleoresin but only when total piperine and related compounds were initially separated by TLC with solvent system (i).

Nature of the compound from argentation-TLC seperation: Argentation-TLC of the isolated piperine and related compounds of a number of pepper samples showed (Table 3) that in most of the cases there were two closely lying spots with R_f 0.82-0.84 (spot 1) and 0.75-0.77 (spot 2) but occasionally a faint spot at R_f 0.55-0.58 (spot 3). The major spot at R_f 0.75-0.77 had the same R_f as pure piperine and gave typical yellow

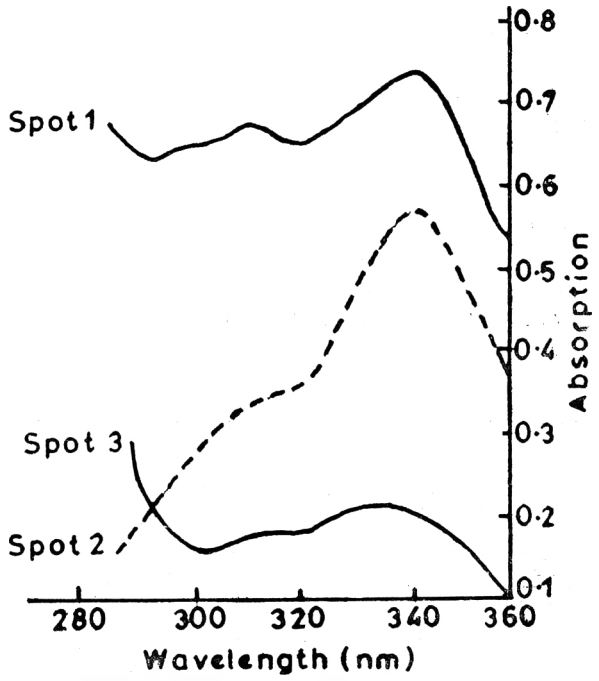

Fig. 2. Spectral characteristics of piperine and related compounds of pepper oleoresin after argentation—TLC separation (solvent-(iv)) Spots 1, 2 and 3 are as given in Table 3.

TABLE 3. PIPERINE AND RELATED COMPOUNDS OF BLACK PEPPER SEPARATED BY ARGENTATION-TLC AND ESTIMATED BY UV

Sample	Spot 1 (R_f = 0.82-0.84)	Spot 2 (R_f = 0.75-.077)	Spot 3 (R_f = 0.55-0.58)
% Piperine related compounds*			
Panniyur (Optimum maturity)	11.6	87.9	0.5
Balankotta	8.4	90.5	1.1
Kuthiravally	13.1	86.0	0.9
Karimunda	11.8	88.2	—
Ceylon	14.4	85.4	0.2
Green pepper	13.5	86.5	—
Garbled pepper	17.8	82.2	—
Light pepper	14.6	85.4	—
Pinhead pepper	14.0	86.0	—
Commercial oleoresin	8.0	92.0	—
Crude piperine	7.4	92.6	—
Pure piperine		100.0	—
Spectral ratio			
342/360	1.17-1.38	1.41-1.52	1.40-1.53
342/309	0.94-1.28	1.45-1.52	1.10-1.26
Pungency (Scoville Units)	25,000	100,000	—

*Calculated from 342 nm absorption and calculated as piperine

colour on spray with chromic acid and 2,4-DNPH. The spectral pattern of this major spot was also typical of piperine and showed pungency in the corresponding area of a co-chromatographed spot and was thus identified as piperine.

The spectra of the other two minor spots varied though the absorption maxima was at 342 nm. The higher R_f spot exhibited higher relative 360 nm absorption while at 309 nm, absorption was high for both the higher and lower spots. Both minor spots being in small proportions showed a whitish colour with acid spray. The possibility that the high R_f spot could be an artifact in argentation TLC was checked by running pure piperine under the same concentration and condition as the total piperine and related compounds from oleoresin. There was only a single spot at R_f 0.75-0.77.

The pungency of the high R_f spot based on 342 nm absorption, calculated as piperine, was only 25×10^3 SU, while that of the major spot identified as piperine was 100×10^3 SU.

The isomers with *cis* configuration would complex with silver ion unlike *trans*, *trans*-piperine and would have lower R_f than piperine in argentation-TLC. The higher R_f compound could not, therefore, be any of these isomers. Since the higher R_f minor component showed the 342 nm maxima, characteristic of conjugated double bond as in piperine, this could not be identified with the saturated analogs, viz., the dihydro-[4] and tetrahydropiperine reported from pepper[10] which have general absorption at around 280 nm.

This high R_f component was estimated in a number of pepper samples by the two steps, TLC-total pungent components isolation followed by argentation-TLC. The results are given in Table 3. The high R_f compound amounted to 7.4 to 17.8 per cent (expressed as piperine) of piperine in different pepper samples. These values are much higher than the estimate of *ca.* 2 per cent for piperylin, the pyrrolidine analog of piperine, recently isolated by Grewe *et al.*[1] and Mori *et al*[5]. TLC analysis of extracts of some of the pepper samples with solvent system (iii) did not show any spot on acid spray or 342 nm absorption or any pungency in the extracts around R_f 0.22 as reported by Mori *et al.*[5] for pyroperine (piperylin).

The piperine and related compounds isolated from the oleoresin through TLC developed with solvent system (ii)[8], was subsequently separated on argentation-TLC. Two spots, a minor component at R_f 0.82-0.84 and a major component at R_f 0.75-0.77 were again found with many samples, the same as the pungent compounds studied with solvent system (i). The pungency of the two spots also agreed with the earlier results, 25×10^3 SU for the minor spot and 100×10^3 SU for the dominant spot.

Piperettine, the trienoic analog of piperine remains to be considered in relation to the high R_f compound. Though the stereoisomeric character of piperettine has not been established by Spring and Stark[3], if the compound has all *trans* configuration and because of its longer chain length, it could not be expected to move higher than piperine in argentation-TLC. The identity of the high R_f compound with piperettine could not, however, be established since the absorption maxima of the high R_f compound is not 364 nm characteristic of piperettine but found at 342nm. However, similar to fractionation experiments described in the earlier part of this paper, the ratio of absorption at 342 and 360 nm was lower compared to that of pure piperine and the ratio obtained for the major spot at R_f 0.75-0.77. It is likely that this high R_f spot is a mixture of compounds related to piperine and piperylin and piperettine. The isomers and analogs of piperine stimulate lower or very little pungency as reported in the literature[1,4,11] and pungency of piperettine is not known. The low pungency is possibly due to a mixture of these analogs or to a small contamination from close lying major piperine spot. Further examination of the minor related compounds in pepper is under study by other powerful TLC separation such as reversed phase techniques and high pressure liquid chromatography.

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Preservation of Salted Casings

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Natural sausage casings prepared from the intestines of animals have certain drawbacks which include incomplete removal of slime, dull colour and inadequate salting. Collection of intestines soon after evisceration and stripping in 0.1N sodium hydroxide not only helps in complete removal of slime but also prevents weakening of the casing due to bacterial proliferation. The incorporation of sodium sorbate/benzoate (0.10%) in the presence of lactic acid (1%) in the equilibrating brine and removal of entrained brine by centrifugation or pressing yielded casings with salt to moisture ratio at saturation. Lactic acid and sorbate/benzoate helped in extending the storage at room temperature (25-30°C) to 9 months. These prevented and reduced bacterial and mould counts avoiding weakening and discolouration of the casing. This curing procedure does not alter the calibre and use of the casing to fill and process sausages.

Intestines which are the major by-products of the abattoir industry are converted into natural sausage casings, guts for sport goods, surgical sutures, etc. Natural sausage casings after salting are exported to Japan in large quantities. The main drawbacks in salted casings are incomplete removal of slime, dull colour, inadequate salting, improper sanitation and non-uniformity of calibration[1]. Therefore, work was undertaken to evolve suitable procedures for collection, removal of slime and salting.

Materials and Methods

Collection: Intestines of sheep, separated from viscera soon after evisceration (20-30 min), were freed from mesenteric attachments without damaging or tearing. The residual ingesta was removed by stripping. Thereafter, the intestines were dipped in 0.2N sodium hydroxide solution and collected in 0.1 N sodium hydroxide soak solution such that the resultant concentration is 0.06N[2].

Removal of slime: The blunt edge of a knife, shell or bamboo reed is used by small scale processors. A wooden clip, similar to that used on the clothes line, 1 in. broad and 6 in. long, with a smooth rod fixed lengthwise on one half of the jaw and a smooth rubber sleeve on the other, was devised for scraping off the slime.

Salting: The present practice of salting involves packing the cleaned casings after removal of the slime with alternate layers of salt in a wooden barrel and tamping the whole mass under a weight so that the water drawn out during salt penetration is expressed out during 3-4 days holding at ambient conditions. The casings are then repacked with sprinkled fine salt. Salting by equilibrating the cleaned casings in saturated salt solution to achieve saturation of the residual water in the casing was done to avoid excess salt. The entrained salt solution was fully drained by pressing the layer of hanks or centrifugation in a wicker basket with the casings loaded along the rim.

Additives: Lactic acid at one per cent and sodium sorbate/benzoate at 0.1 per cent in the saturated salt solution for equilibration were incorporated.

Calibre measurement and end use: The diameter was measured using a spherometer while the casing was kept fully expanded by blowing air or filling sausage emulsion.

Analysis: Methods of A.O.A.C.[3] and A.P.H.A.[4] were followed for estimating moisture, salt and bacteriological status.

Results and Discussion

The efficacy of use of dilute sodium hydroxide in improving the efficiency of removal of slime from the intestines was demonstrated earlier[5]. Sodium hydroxide (0.06N) was chosen because of its effectiveness in loosening the adhesion between the submucosa and other components of the intestines and absence of alkaline feel by the operator. To achieve the desired concentration of sodium hydroxide, the stripped intestines were dipped in 0.2N sodium hydroxide solution and then soaked in 0.1N sodium hydroxide solution, for the required contact time. A volume of 500 ml of 0.2N sodium hydroxide is sufficient for 8 intestines. These intestines were soaked in 300 ml of 0.1N sodium hydroxide solution to ensure that the concentration of sodium hydroxide was maintained at not less than

0.05N. The concentration of sodium hydroxide in the dip solution reduced to 0.1N after dipping 8 intestines, which can then be used as soak solution. A contact period of 30 min was found optimum and signs of weakening were noticed beyond 2 hr. The present practice of soaking in chilled water to achieve loosening of adhesion of slime depends on bacterial action[1] which can result in incomplete removal of slime or weakening of the submucosa. Sodium hydroxide has got the additional advantage of preventing bacterial proliferation[2].

Removal of slime by scraping using blunt knife edge, shell or bamboo reed has the disadvantage of the required pressure and pull being exerted by the fingers of the operator. The pressure exerted is vertical along the cross section of the intestine and the pull along the longitudinal axis of the intestine. These tend to vary along the length of the intestine when done with fingers. Use of the clip-like gadget has the advantage of allowing the operator to concentrate on the removal of the slime by the longitudinal pull, the pressure exerted by the spring being constant. The variation in removal of slime or index of sliming tends to be larger in the case of commercial casings than in casings prepared using the clip-like gadget in the laboratory[5]. Liberal amounts of water have to be used during the removal of slime to wash off the separated material. Removal of slime using the casing cleaning machine was also facilitated by soaking in dilute sodium hydroxide.

The next step of grading was done by filling a small length of the whole casing with water. The diameter was measured by fitting the water filled loop of casing held as a catenary in the different calibrated slots of a wooden calibrating frame. The water was slid along the length of the casing measuring the diameter at suitable intervals of length. When the variation in measurement changed by nearly 2 mm that length of the casing was cut and thus lengths differing by 2 mm were collected. The grading was in terms of diameter and was expressed in steps as 18-16, 16-14, etc. or 19-17, 17-15, etc. Sheep intestine used in these studies yielded casings of calibre 18 to 12 mm, out of which 80 per cent were in the range of 16-14 and 14-12.

The graded pieces were made into hanks[6] and equilibrated in salt solution prepared using common salt. The equilibration was done in two stages. The graded hanks were collected in saturated salt solution containing some extra salt. The salt pick-up was expressed in terms of salt to moisture ratio as percentage in fully drained hanks (Table 1). After two hours equilibration salt/moisture was 23 per cent. The ratio could be increased by equilibrating again in saturated salt solution. After 8 hr equilibration in this second stage solution the salt/moisture attained was near saturation. But for practical purposes it was more convenient to equilibrate for an overnight period. Eight intestines needed 500 ml of the salt solution for efficient equilibration. Reuse of the first stage solution was not advisable due to bacterial build-up. The second stage solution can be reused at least three times by replenishing only the salt thus economising on the consumption of the additives.

The bacteriological counts at the four stages of processing, from raw intestines to finished casing are shown in Table 2. During the processing the initial count of $11\text{-}19 \times 10^4$ has been reduced to $0.1\text{-}0.3 \times 10^4$ per g.

During storage for two months, the total count in salt cured casings increased from 9×10^3 to 3×10^6 which was an undesirable level. The inclusion of lactic acid in the curing brine not only reduced the initial counts to 2.8×10^3 but also curbed the proliferation during storage of two months to 4×10^3. Lactic acid also showed a beneficial effect in reducing the initial halophile counts from 3.5×10^3 in salt cured casings to 1.2×10^3. After the storage of the casings for two months, even though the counts of halophile were only 2.8×10^3, a few mould spots were observed. This was curbed by including sodium sorbate/benzoate in the curing brine with lactic acid.

The bacteriological counts in the casings cured in brine containing lactic acid and sodium benzoate/sorbate increased to $8\text{-}10 \times 10^3$ during the first two and half months (Table 3). Subsequently, the counts decreased steadily. At the end of 9 months storage, the

TABLE 1. UPTAKE OF SALT IN CASINGS EQUILIBRATED IN SATURATED SALT SOLUTION

Equilibration time (hr)	Salt (%)	Moisture (%)	Ratio (%)
2	17.3	73.3	23.5
24/overnight‡	20.8	59.1	35.2
24/overnight*	23.1	61.2	37.7

‡Drained by pressing 7 kg for 3 hr

*Drained by centrifugation-1000 rpm for 15 min

TABLE 2. BACTERIOLOGICAL COUNTS OF INTESTINES AT DIFFERENT STAGES OF PROCESSING

Treatment	Total plate count ($\times 10^4$)
Before alkali soaking	11-19
After alkali soaking	1.6-1.9
After slime removal	0.3-0.4
After salting	0.1-0.3

TABLE 3. BACTERIOLOGICAL STATUS OF SALT CURED CASINGS DURING STORAGE AT ROOM TEMPERATURE

Storage period (months)	Salt+Lactic+Sorbate	Salt+Lactic+Benzoate
	Total plate count / g × 10^3	
Initial	1.2	1.1
2.0	4.0	5.2
2½	8.0	10.0
3.0	8.0	5.0
3½	7.0	4.0
4.0	3.0	2.0
4½	0.4	1.0
5.0	0.4	1.0
5½	0.9	0.9
6.0	0.9	0.2
9.0	0.4	0.2
	Halophiles / g × 10^3	
Initial	0.9	0.9
2.0	2.2	0.6
2½	2.0	0.5
3.0	0.2	0.2
3½	0.1	0.1
	Yeast and Moulds / g	
Initial	30	30
2.0	240	220
2½	10	10
3.0	Nil	10
3½	Nil	Nil

counts were 0.2-0.4 × 10^3. Halophiles as well as yeast and mould count also showed the same trend.

Lactic acid (1 per cent) and sodium sorbate/benzoate (0.1 per cent) could be incorporated in the second stage equilibrating solution to obtain longer storage life of 9 months when the hanks were held at ambient temperature of 25-30°C packed in polythene bags and kept in plastic jars. Incorporation of lactic acid in the second stage equilibrating solution lowered the pH of the cured casings to 2.5-3.5. Uptake of sorbate/benzoate by the casings was not estimated because the cured casings were soaked in water before use. Signs of weakening of the casing have been noticed beyond 9 months storage by evaluation to process sausages using the stored casings.

Measurements of diameter were taken in uncured, cured and stored casings (Table 4). The variations in

TABLE 4. EFFECT OF CURING ON CALIBRE OF CASING

Treatment	Calibre (mm)
Puffed by air	
Uncured	14.91
Cured with salt	14.81
Cured with salt+Lactic+Sorbate/ Benzoate	15.09
Filled sausages	
Uncured	16.02
Cured with salt	15.73
Cured with salt+Lactic+Sorbate/ Benzoate	15.96

diameter along the length of the casings was distributed uniformly to these three conditions by cutting the length of the casing into the meter long pieces and sequentially distributing among the three. The data in Table 4 show that the calibre has not been affected by the treatment and storage. Similarly the sodium hydroxide treatment does not reduce the tensile strength[2].

The principal advantage of the present technique is the efficient removal of slime, salting to minimum adequate level and extended storage (9 months) at ambient temperature (25-30°C) due to the saturation of the water in the casing with sodium chloride, and presence of lactic acid and sodium sorbate/benzoate. The salt curing procedure outlined does not alter the calibre and use of the casings to fill and process sausages.

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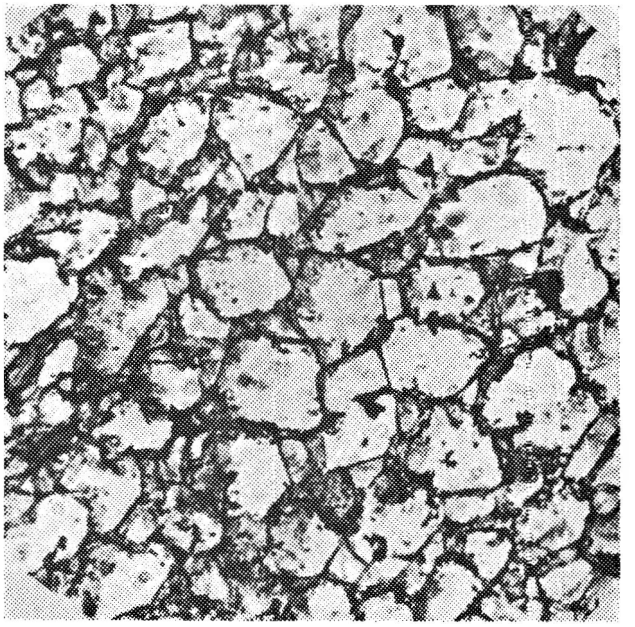
RESEARCH NOTES

HISTOLOGICAL EVIDENCE FOR THE RECONSTITUTIONAL PROPERTY OF DRIED/ DEHYDRATED RAW MANGO SLICES

Histological studies revealed that the higher reconstitution ratio in cabinet dried raw mango slices as compared to sun-dried slices was due to less rupture of cells during drying in cabinet drier than during sun-drying. The studies also showed thinner and less continuous cell wall in dried and dehydrated raw mango slices after reconstitution as compared to fresh raw mango slices.

Acceptability of the dried and dehydrated food is dependent on its reconstitution property which is primarily determined by the cellular structure. Shrinkage of cell surface occurs during dehydration and severe shrinkage leads to cell wall rupture[1]. According to Matz[2] the rapidity with which water is removed from hot material determines its texture quality; for getting an acceptable texture water must be removed rapidly. Lee *et al*[3]. investigated the histological difference between air dried and vacuum dried apricots and observed that the cell walls of the hot air dehydrated fruits were thinner and less continuous than that of the fresh fruits. Reconstitution property of the mango slices dried in sun and in cabinet drier in relation to their cell structure is presented in this note.



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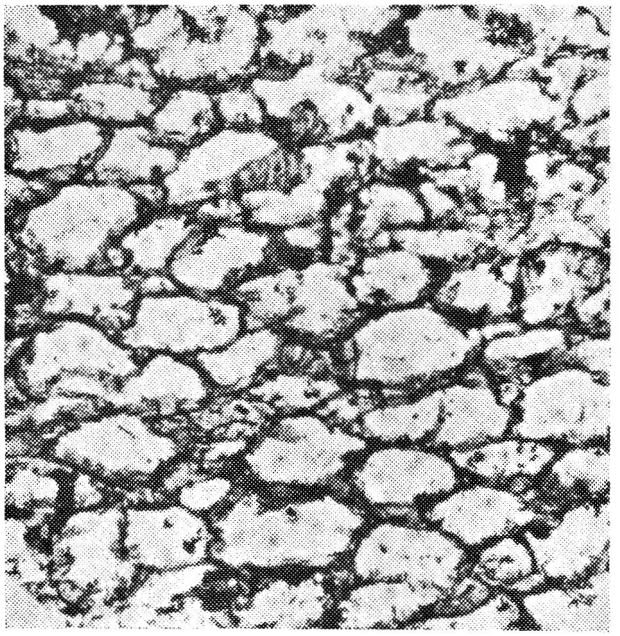

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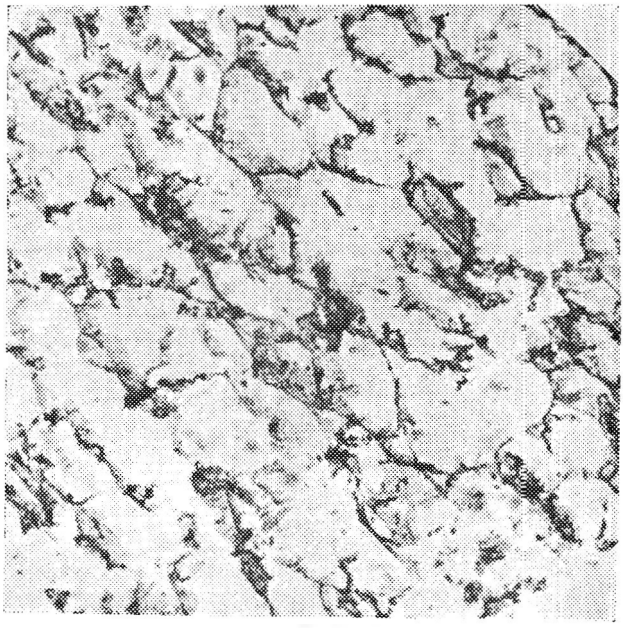

C

Fig. 1. Microphotograph of reconstituted raw and dried mango slices.

A. Fresh raw mango slices showing intact cells with thick cell walls.
B. Cabinet dried raw mango slices showing ruptured cells with thin cell walls.
C. Sun-dried raw mango slices showing extensive rupture of cells with thin cell walls.

Reconstitution property of the mango slices dried in sun and in cabinet drier in relation to cell structure is presented in this note. Raw mango slices dried in sun and in cabinet drier were reconstituted as mentioned by Bhatia *et al*[4]. and cut into suitable pieces, with minimum bruising, compression and desiccation. These were compared with fresh green mango pieces. The pieces were immersed in fixing fluid consisting of a mixture of formalin, acetic acid and alcohol (FAA) in the ratio of 5:5:90 and shaken intermittently to effect better penetration of the fluid and to facilitate air removal. The pieces were kept in FAA for 24 hr and gradually dehydrated using increasing concentrations of alcohol, gradually infiltrated with paraffin and finally embeded in paraffin blocks. Microtome sections of 10μ size were taken and stained with 1 per cent haematoxylin[5] and were examined under microscope. Intact cells per unit area were counted using a camera lucida[6]. Microphotographs of the microscopic fields were also taken.

In the present investigation, differences were observed in the cell structure of fresh, cabinet dried and sun-dried reconstituted raw mango slices. The cell count-data are given in Table 1 and microphotographs of the microscopic fields are in Fig. 1A, 1B and 1C. In the fresh tissues, all the cells were intact with thicker cell walls. In the reconstituted cabinet dried raw mango slices percentage of cell rupture was less, per cent intact cells were almost double as compared to reconstituted sun-dried slices (Table 1). The cell counts per unit area and the microphotograph gave satisfactory evidence of greater rupture of cells in sun-dried (Fig 1C) slices as compared to cabinet dried (Fig. 1B) ones. These findings can be substantiated with those of Matz[2].

In the present study it is seen that the cell walls of both cabinet dried and sun-dried slices were thinner as compared to fresh slices. Though the difference in the cell wall thickness could not be measured, it could possibly be inferred from the microphotograph that the cell walls of the sun-dried slices were thinner than those of cabinet dried slices and resulted in more rupture of cells. Thinner cell walls could possibly be due to degradation of pectic substances; this was also observed by Lee[3] in dehydrated apricots. On the basis of these findings, it could be stated that comparatively low reconstitutional rate in the sun-dried raw mango slices was due to greater rupture of cells during sun-drying as compared to drying in cabinet drier.

TABLE 1. INTACT AND RUPTURED CELLS PER UNIT AREA IN FRESH AND RECONSTITUTED MANGO SLICES IN RELATION TO THE RECONSTITUTION RATIO

Treatment to mango slices	*No. of intact cells (5×5 cm)	*No. of ruptured cells (5×5 cm)	% cell rupture	% intact cells	Reconstitution ratio
Fresh raw mango slices	55	Nil	Nil	Nil	—
Cabinet dried reconstituted	35	20	36.4	63.6	3.90
Sun-dried reconstituted	18	37	67.3	32.7	3.37

*Av of 10 microscopic fields (25 sq cm under 43×10 magnification)

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STUDIES ON CONTROL OF SOUR ROT IN NAGPUR ORANGES (*CITRUS RETICULATA* BLANCO)

In Nagpur oranges (*Citrus reticulata* Blanco) spoilage due to sour rot accounts for more than 60 percent of the total wastage. Treatment with a combination of Calixin at 1000 ppm and Benlate-50 at 0.1% in 5% wax emulsion was effective in lowering the spoilage from 63 to 6 percent in *Ambia Bahar* (October-January) crop during a storage period of 20 days. The results were similar in *Mrig Bahar* (February-May) crop also. Dipping oranges for 2 min in an aqueous suspension of Calixin (1000 to 5000 ppm) and Benlate-50 (0.1%) was beneficial in reducing wastage to less than 1 percent but the fruits became unmarketable after 7 days of storage under ambient conditions.

Nagpur oranges are beset with fungal spoilage during their transport and marketing at far off places in the country. In the earlier studies[1,2] on storage of Nagpur Mandarin oranges, micro-organisms causing spoilage were isolated and their typical symptoms on the fruits were described. Sour rot due to *Geotrichum candidum* alone accounted for 74 per cent of spoilage. In recent years, control of sour rot particularly in the later part of the harvest seasons has become a great necessity in the marketing of oranges.

Zineb, M. E. Tosbhy and Sinclair J. B.[3] observed that 27°C was the optimum temperature forc ausing decay in deeply wounded oranges by the nine plant isolates of *Geotrichum candidum*. Christ[4] noted that sour rot was prevented if oranges were transported and stored at 4 to 5°C. Thirumalachar[5] indicated the use of aureofungin at 100 ppm for the control of sour rot. Laville[6] found that Tridemorph or Calixin, at 50 ppm *in vitro* or dip in 1000 ppm gave effective control of sour rot. An attempt has been made to study the effect of Calixin and Benlate-50, with and without wax emulsion in controlling sour rot in Nagpur Mandarin oranges, when they are packed in ventilated wooden cases provided with cushioning pads.

Sound and mature fruits, picked carefully from an orchard at one week interval, were treated in the laboratory within 24 hr. The fungicides used were (*i*) Benlate-50* [Methyl-1 (butyl carbamoyl)–2-benzimidazole carbamate], (*ii*) Tridemorph or Calixin** [N-tridecyl-2, 6-dimethyl-morpholine], and (*iii*) a combination of Benlate-50 and Calixin. The wax emulsion used was from the Central Food Technological Research Institute, Mysore. The treatments given were:

Ambia Bahar (*October-January*) *crop:* (*i*) Control, (*ii*) Calixin at 1000 ppm in wax emulsion, (*iii*) Benlate at 0.1 per cent in wax emulsion, and (*iv*) Calixin (1000 ppm)+Benlate at 0.1 per cent in wax emulsion for 2 min.

Ten replicates of 100 fruits each were used for all treatments except for the last one in which five replicates were used. When the last treatment was repeated in the next Ambia Bahar season, five replicates were used. The experiments were conducted during 1977 and 1978.

Mrig Bahar (*February-May*) *crop:* (*i*) Control, (*ii*) Calixin at 1000, 3000 and 5000 ppm with 0.1 per cent Benlate in wax emulsion, and (*iii*) two minutes dip in Calixin at 1000 to 5000 ppm+Benlate at 0.1 per cent.

Seventy five fruits each were used for the first two treatments and two replicates were used for the last treatment. The fruits were packed in four layers in a ventilated wooden case of dimension 39.0 (L) × 30.5 (B) × 29.0 (H) cm. Paper pad containing dry grass was used as cushioning material in between the layers.

The marketability of the fruits was assessed at the end of the experiment by noting gloss, colour, texture, taste, flavour and quality by a 5-member panel in the laboratory.

In the earlier studies[2] treatment with 6 per cent wax

TABLE 1. EFFECT OF FUNGICIDES AND THEIR COMBINATIONS ON CONTROL OF DECAY IN *AMBIA BAHAR* CROP

Treatment	% cumulative spoilage			
	5 days	10 days	15 days	20 days
Year 1977*				
Control (no waxing)	1.9	11.6	26.9	34.8[a]
Calixin (1000 ppm) in 5% wax emulsion for 2 min	1.5	4.8	7.3	9.5[b]
Benlate (0.1%) in 5% wax emulsion	2.1	5.5	9.1	11.9[b]
Calixin (1000 ppm)+Benlate (0.1%) in 5% wax emulsion, for 2 min	1.1	3.2	4.0	5.2[b]
Calixin (1000 ppm)+Benlate (0.1%) dip for 2 min	0.8	2.0	3.8	5.6[a]
Year 1978**				
Control	11.4 (7 days)	32.4	51.6	63.4[a]
Calixin (1000 ppm)+Benlate (0.1%) in 5% wax emulsion	3.2 (7 days)	5.8	5.8	6.0[b]

Storage : Ambient condition Temp. range : Min. 10°C±3
RH : 50-70% Max. 20°C±3

a : Fruits lost their marketability after 7 days storage.
b : Fruits remained marketable upto 20 days storage.
*1000 fruits were taken for each study.
**500 fruits were taken for each study.

*Benlate-50 supplied by Agromore Ltd., Bangalore-6, India.
**Calixin supplied by BASF India Ltd, Bombay-400 011 India.

emulsion containing Benlate-50 at 0.1 per cent concentration controlled post-harvest storage decay for 20 days under ambient conditions. It was not, however, specific against *Geotrichum candidum*. Calixin is specific for the control of sour rot in citrus fruits caused by *Geotrichum candidum*[6]. It has no adverse effect on the stability of the wax emulsion. A comparative study of Benlate and Calixin singly and in combination was, therefore, carried out.

The spoilage in the untreated fruits was considerably higher due to adverse atmospheric conditions during packing and storage. Inspite of this, combination of Calixin (1000 ppm) with Benlate-50 (0.1 per cent) minimised the decay to about 5 per cent during 20 days storage. However, Calixin and Benlate-50, when applied individually were not found to be so effective as the combination (Table 1).

TABLE 2. EFFECT OF HIGHER DOSES OF CALIXIN IN COMBINATION WITH BENLATE-50 ON CONTROL OF DECAY IN *MRIG BAHAR* CROP

Treatment	% cumulative spoilage	
	7 days	15 days
Control (no wax coating)	4.0	12.60[a]
Calixin (1000 ppm)+Benlate (0.1%)	Nil	1.33[b]
Calixin (3000 ppm)+Benlate (0.1%)	Nil	1.33[b]
Calixin (5000 ppm)+Benlate (0.1%)	Nil	1.33[b]

a : Fruits lost their marketability after 7 days storage

b : Fruits remained marketable upto 21 days storage.

75 fruits were taken for the study.

Fruits were treated with 5% wax emulsion for 2 min, except control.

Although the dip treatment was effective in minimising the decay, the treated fruits lost their marketability after 7 days storage. In wax coated fruits the decay was less than 2 per cent after 15 days storage at all the concentrations (Table 2). The optimum level of Calixin is 1000 ppm; higher concentrations did not show any additional advantage. Further trials using Calixin (1000 ppm) and Benlate-50 (0.1 per cent) were repeated in the 1978 Ambia Bahar season.

Fruits coated with wax emulsion containing 1000 ppm Calixin+Benlate (0.1 per cent) showed only 6.0 per cent spoilage as against 63.4 per cent in untreated fruits (Table 1).

Besides sour rot, decay is also caused by *Penicillium* (blue and green), *Candida* sp., *Alternaria* (stem end rot), *Phytophthora* (brown rot), *Gloeosporium follicum* (Anthracnose rot), *Aspergillus niger* and an unidentified cottony rot. Different types of spoilages were identified in the decayed fruits. Combination of Benlate-50 (0.1 per cent) and Calixin (1000 ppm) reduced spoilage due to sour rot from 60.9 to 11.5 per cent and that due to *Penicillium* rot from 14.4 to 3.9 per cent. Total spoilage was lowered from 34.8 to 5.2 per cent (Table 3).

Although the mixed fungicide wax coating treatment proved to be the most effective treatment for controlling the overall decay, it was not quite effective against rots caused by *Candida* sp., *Alternaria* (stem end rot) and the unidentified cottony mold, which together, however, account for only a small per cent (5 per cent) of the total decay in the treated fruits. It is proposed to verify these findings in large scale trials before recommending for adoption in commercial practice.

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TABLE 3. EFFECT OF FUNGICIDE TREATMENT ON THE DIFFERENT KINDS OF SPOILAGE EXPRESSED AS PER CENT OF TOTAL SPOILAGE

Treatment	Control	Calixin (1000 ppm) + Benlate (0.1%) in 5% wax emulsion for 2 min	Calixin (1000 ppm) in 5% wax emulsion for 2 min	Benlate (0.1%) in 5% wax emulsion
Total spoilage	34.8	5.2	9.5	11.9
Sour rot (*Geotrichum candidum*)	60.9	11.5	24.2	54.6
Candida rot	10.0	32.7	33.7	15.1
Penicillium rot (Blue & green)	14.4	3.9	20.0	1.7
Stem end rot (*Alternaria* sp.)	9.0	25.0	10.5	26.9
Cottony rot (*Unidentified*)	3.1	15.4	3.2	—
Brown rot (*Phytophthera* sp.)	0.3	5.8	4.2	0.85
Anthracnose rot (*Gloeosporium* sp.)	0.6	5.8	2.1	0.85
Aspergillus rot	1.7	—	2.1	—

1000 fruits were taken for each study

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FRACTIONATION OF LEAF PROTEINS OF LUCERNE (*MEDICAGO SATIVA*) UNDER LOW PH–LOW TEMPERATURE TREATMENT

Leaf proteins were fractionated from a lucerne extract by adjustment to pH 5.5 and keeping for 2 hr at 4°C, followed by centrifugation. About 38 per cent protein and 4 per cent chlorophylls of the extract were recovered in the supernatant fluid. Dark green chloroplastic leaf protein concentrate (LPC) contained 55-65 per cent protein whereas pale green cytoplasmic LPC had 80-85 per cent protein.

Fractionation of leaf proteins into chloroplastic and cytoplasmic fractions has been done by various methods *viz.*, centrifugation, heat, organic solvents and poly-anionic flocculants[1-4]. We report below results of fractionation by a low pH-low temperature treatment of the leaf extracts.

Fresh vegetation of lucerne (*Medicago sativa*) was pulped in a vertical cutter[5] and pressed in a basket press to get leaf extract. After adjusting the pH, centrifugation was done at 6000 rpm for 15 min and the sediment and supernatant fluid were analysed for protein and chlorophyll. Trichloroacetic acid insoluble nitrogen was determined by a micro-Kjeldahl method and the protein expressed as $N \times 6.25$. Chlorophyll was assayed by the standard AOAC method[6]. Chloroplastic and cytoplasmic leaf protein concentrates (LPC) were prepared by heating to 90°C the sediment (dispersed in water) and the supernatant fluids respectively and separating and drying the coagulated materials.

Preliminary studies over a range of pH 3-7 showed that the extracts adjusted to pH 5.0 or below, on centrifugation yielded a supernatant, golden yellow in colour, indicating total absence of chlorophyll. The supernatant fluid from the pH 5.5 adjusted extract was turbid green. When this supernatant fluid was kept at 4°C most of the chloroplastic material settled down in 4 hr leaving a non-green supernatant fluid.

Therefore, a study was done with the leaf extract adjusted to pH 5.5 and kept at 4°C for different periods to determine the distribution of protein and chlorophyll in chloroplastic sediment and the supernatant fluid. The results are presented in Table 1. During 2 hr of storage at 4°C, the proportion of chlorophyll in cytoplasmic fraction reduced from 10.6 to 4.8 per cent and that of protein from 47 to 38 per cent. This decrease in chlorophyll and protein in cytoplasmic fraction is reflected in higher recoveries in chloroplastic fraction. These results suggest autocoagulation of chloroplastic proteins, thereby giving low recovery in cytoplasmic fraction, as the time of storage increases. We also found that when the pH 5.5 adjusted extract was kept at 4°C there was no total recovery of the original protein in the two fractions. The optimum pH for proteolysis has been reported to be 5.5[7,8]. It is evident that even at low temperature there is some autolysis of proteins. A similar decrease in recovery of total extract chlorophyll in two fractions suggest both chlorophyllase action[9] as well as loss in breakdown products passing into the aqueous phase under acidic condition.

Possibilities of obtaining higher amounts of cytoplasmic protein at pH higher than 5.5 were also tried. At pH 5.75 and 6.0 the supernatant fluids obtained were dark green in colour and on being kept at 4°C for 2 hr, about 20 and 31 per cent chlorophyll respectively remained in the supernatant fluids.

The dark green chloroplastic LPC contained 55 to 65 per cent protein whereas pale green cytoplasmic LPC had 80-85 per cent protein.

TABLE 1. PER CENT DISTRIBUTION OF CHLOROPHYLL AND PROTEIN IN CHLOROPLASTIC AND CYTOPLASMIC FRACTIONS FOLLOWING CENTRIFUGATION OF PH 5.5 EXTRACT STORED AT 4°C

Storage period (hr)	Chlorophyll		Protein	
	Chloroplastic fraction	Cytoplasmic fraction	Chloroplastic fraction	Cytoplasmic fraction
0	89.4	10.6	53.0	47.0
1	93.2	6.8	57.6	42.4
2	95.2	4.8	61.6	38.4

To summarise, the chloroplastic fraction of leaf proteins can be flocculated by adjusting the pH of extract to 5.5 and holding at 4°C for 2 hr. The supernatant, following centrifugation will yield an almost pigment free LPC of high protein content, representing more than one third of the total extract protein.

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SHELF-LIFE OF READY-TO-EAT FRIED NOODLES

Shelf-life of ready-to-eat extruded noodles (*Sev* or *Muruku* made from a blend of corn and soy flours and milk powder) fried in groundnut or soybean oil in a 30-t/day continuous plant was investigated. No significant changes were observed in free fatty acid content of oil extracted from the noodles during storage at ambient temperature for 70 days. Peroxide values (m.eq./kg) increased from 4.5-5.8 to 6.6-13.6 and 2.4-3.0 to 6.7-6.8 respectively for products fried in groundnut and soybean oils during storage. Organoleptic acceptability, which did not correlate with peroxide value was good for 35 days and 20 days for noodles fried in groundnut oil and soybean oil respectively. Incorporation of spices into flour prolonged the shelf-life in both the noodles.

Ready-to-eat noodles (*Sev* or *Muruku*) are manufactured by extrusion process and fried in a 30 t per day continuous deep-frying plant. These are distributed to 3 lakh school children (5-11 years of age) under the Mid-day Meals Programme of the Government of Andhra Pradesh (India). The stability of the frying oil (groundnut oil) was found to depend on the turnover rate of oil in the fryer[1]. These noodles take some time after preparation for their distribution and consumption. Hence an attempt was made to study the shelf-life of noodles fried in groundnut and soybean oils, the results of which are reported in this communication.

The ingredients used like corn and soy flour blend and milk powder as well as frying oil (refined groundnut or soybean oil) are supplied by the United States of America through CARE. The imported oils contained 0.005 per cent citric acid as metal inactivating agent, oxystearin as antifoaming agent and antioxidant (BHA) to improve the keeping quality and performance of the oil during frying.

The noodles were fried at 180°C in a continuous fryer as described earlier[1]. The process involves preparing the dough from corn-soy-milk powder blend followed by extruding into strands. These are then fried in a frying equipment containing 2.5 t of groundnut/soybean oil at 180°C for one minute. The oil from the fryer is circulated through the heat-exchanger, where it is heated to the required temperature by steam. Common salt at 1.5 per cent and spice powder consisting of cumin seed (*Cuminum cyminum* Linn) and *Curry* powder (procured from market) were incorporated at 0.5 per cent levels to the flour blend. The fried noodles were packed in non-transparent, high density, black plastic containers of 12-kg capacity and stored at ambient temperature (32 to 34°C) for 70 days. They were analysed at regular intervals for moisture, oil, free fatty acids and peroxide value according to methods of AOCS[2].

Organoleptic evaluation for odour and taste was carried out by a panel of 8 persons. They were asked first to arrange the samples by odour alone so that, the best odour is tasted first. The time for tasting the product by the panel was also kept constant. The organoleptic acceptability was classified as good or poor when 70 per cent of the panel accepted or rejected the product respectively. Relevant data are given in Table 1.

Moisture content of the product ranged from 4.5 to 7.6 per cent and the changes in moisture occurring during storage (0.3-1.1 per cent) were insignificant. In fried products with low moisture content hydrolytic rancidity is not important, specially with frying oils such as groundnut or soybean which do not contain short-chain fatty acids[3,4]. In fact, low moisture content in such products can provide protection against oxidative rancidity[5]. Further, hydrolytic enzymes are destroyed during frying[3]. The free fatty acid contents (calculated as oleic) of extracted oil were low (0.7-2.8 per cent) and the increases (0.1-0.9 per cent) were not significant. The product contained oil in the range of 19.0-23.3 per cent and the variations during storage (0.4-1.3 per cent) were insignificant.

TABLE 1. CHANGES IN PEROXIDE VALUE OF THE OIL EXTRACTED AND ORGANOLEPTIC PROPERTIES DURING STORAGE OF READY-TO-EAT EXTRUDED NOODLES FRIED IN GROUNDNUT AND SOYBEAN OILS

Storage period (days)	Groundnut oil fried				Soybean oil fried			
	Without spices		With spices		Without spices		With spices	
	P.V. (m.eq./kg)	Accept-ability	P.V. (m.eq./kg)	Accept-ability	P.V. (m.eq./kg)	Accept-ability	P.V. (m.eq./kg)	Accept-ability
0	4.5	Good	5.8	Good	3.0	Good	2.4	Good
21	5.0	Good	6.0	Good	4.0	Good	—	—
35	5.5	Good	6.8	Good	5.0	Poor	2.7	Good
42	5.8	Poor	7.0	Good	5.4	Poor	3.5	Poor
51	—	—	—	—	6.0	Poor	3.9	Poor
56	6.2	Poor	8.0	Poor	—	—	—	—
63	6.9	Poor	10.5	Poor	6.3	Poor	5.4	Poor
70	6.6	Poor	13.6	Poor	6.8	Poor	6.7	Poor

Peroxide value (m.eq./kg) of oil in the fried product increased from 4.5-5.8 to 6.6-13.6 and 2.4-3.0 to 6.7-6.8 for products fried in groundnut oil and soybean oil respectively during storage. It has been reported[6] that rancidity is perceptible only when peroxide value of stored samples fried in vegetable oils is more than 50. But even under low peroxide value, off-odour and bitter tastes were noticed in the stored product and no correlation could be established between the peroxide value and organoleptic acceptability. However, organoleptic acceptability became poor when the peroxide value reached 3.8-8.0 m.eq./kg. for *Sci.* with spices and fried soybean oil and groundnut oil respectively. The peroxide value ranged from 4.5 to 6.6 m.eq./kg for samples fried in groundnut oil and stored for 70 days; the product was orangnoleptically considered 'Good' up to 35 days of storage beyond which it was of 'Poor' quality. When the samples were fried with spices it was in 'Good' condition upto 42 days when the peroxide value was 7.0; and the maximum value of peroxide reached was 13.6 during 70 days of storage.

Samples fried in soybean oil kept 'Good' for 21 days only when the maximum peroxide value reached was 4.0. By mixing with spices it kept in 'Good' condition only upto 35 days when the peroxide value was 2.7 m.eq./kg. Mixing of spice did not allow the peroxide value to increase in samples fried in soybean oil (Table 1).

The inadequacy of simple chemical means such as determination of peroxide, carbonyl and thiobarbituric acid values to support organoleptic evaluation is well known, particulary for complex fried food products[7,8]. Spices are known to possess antioxidant properties[9].

It can be concluded that noodles fried in groundnut oil could be stored for 35 days and those fried in soybean oil upto 20 days. Mixing with spices however improved the shelf-life of groundnut fried product to 42 days and soybean fried product to 35 days.

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REVIEW PAPER

Chromium Coated Steel Plate as an Alternative to Tinplate for Canning Food Products

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Chromium coated steel plate has been developed in advanced countries as an alternative to tinplate for canning food products. Possibilities of similar development in India are being explored at CFTRI, Mysore. This article reviews the development and suitability of chromium coated steel plates.

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Introduction

Normally cans fabricated from low carbon steel plate coated with a thin layer of tin on either side are used for canning food products. Owing to shortage of metallic tin and its high cost, attempts have been made in some countries to replace tin with cheaper chromium metal. Japan and the USA have already developed and introduced such containers on commercial scale for packing certain food products and non-food items.

India spends considerable foreign exchange to import tin while chromium is available within the country. Studies have been initiated at CFTRI, Mysore to assess the suitability of both indigenously manufactured and imported chromium coated steel (TFS) for canning low acid and dry food products. Recent literature[1-20] has been surveyed in this review regarding developments in the manufacture of TFS and its suitability for canning different food products.

Manufacture of tin-free steel

Chromium coated steel plate is normally manufactured by electroplating cold rolled steel plate with chromic acid. Toyo Kohan Co. Ltd. of Japan has developed a variety which is cheaper and has better rust resistance than E 5.6/5.6 tinplate. In the process of manufacture chromic acid is reduced electrolytically on the steel surface to form a chromic oxide coating, which is light blue or bluish purple in colour. This process does not leave toxic compounds such as chromate or dichromate on the steel and it can be formed or drawn in the same way as tinplate or sheet steel. During severe forming it is recommended to lubricate the surface[21].

Two other types developed in Japan are Cansuper and Hinac coat. Cansuper is manufactured by electroplating of cold rolled steel sheet with chromic acid. Hinac coat is manufactured by treating cold rolled steel strip with an emulsion containing chromic acid and an organic high polymer as main constituents combined with high temperature baking for a short time[1].

Another type developed in Japan is known as "Stainless Weirchrome". This is offered in commercial tinplate guages with electrolytically deposited metallic chrome coating on both sides of the steel. The chrome film coating ranges from 0.1×10^{-6} to 0.5×10^{-6} in. thick (i.e. 0.1 to 0.5 micro in.)[22].

Current output of TFS in Japan is about 2000 metric tonnes per month[23]. For beer and beverage cans, thickness of electrolytically deposited chromium is about 3 micro in. Apart from electroplating there are other chromising processes[4].

A new type developed in USA eliminates a major disadvantage—the tendency to fracture badly during fabrication due to excessive thickness of the chrome layer resulting in significant iron pick-up and rusting of the external surface[24]

Can fabrication

Soldering of chromium coated steel strip, unlike the conventional can making, is difficult. A new flux 'T77' has been developed by Fry's Metal Foundries for this purpose[25]. However, the practice now is to weld or cement the side seam. Two types developed in America are Mira Seam (American Can Co.) and Conoweld (Continental Can Co.)[26].

Mira seam[26-29]*:* In this a body blank precoated on both sides with a tailored epoxy enamel receives a thin ribbon of thermoplastic (nylon) adhesive along preheated edge. The cement is cooled and the blank is transferred to a body maker. Here the blank is reheated to about 450°F and the cement and the blank are bumped with chilled steel to bound $\frac{1}{4}$ in. overlap seam. The equipment has a capcity of producing 600 cans per min[26]. For the manufacture of these cans, fewer machinery motions are required than for conventional can making, in which

the side seam ends must be formed, hooked, then soldered and set for cooling[24].

Conoweld: In this the coating on the blank is stripped away to the base metal along the narrow edge to be welded. Blank edges are overlapped 1/16 in. spot welded and then subjected to high intensity (250,000 amperes) short duration welding heat, along the entire seam. The cut edges are actually burried in the joint itself and the seam coated with an epoxy powder. This system operates in the range of 450 to 600 cans per min[26]. There are many new techniques in the high speed welding[30–32].

Forge welding: In this process the edges of the body blank where the steel is to be welded are cleaned to remove any oxide layer and are overlapped approximately 0.04 in. at the side seam to form the can cylinder. Heat and pressure necessary to weld the side seam are applied[33].

Shaped cans: TFS beer cans are shaped to resemble miniature beer kegs. This is done by a process using high pressure hydraulic presses to shape them. Side seam is welded[34,35].

The problems of lacquering[36] and printing (lithography[5,8,37]) have been discussed by various workers.

Recent trends in industry include three piece TFS can with either cemented or welded side seams for two piece drawn and ironed (DWI) cans,[38–40] draw redraw (DRD) cans[39] and cans with steel easy open ends specially for beverages[41–43].

Properties of TFS

The base layer of chromium acts as corrosion barirer. The superimposed layer of chrome oxide prevents the oxidation of the chrome surface and covers up discontinuities such as pin holes in the elemental chrome and thus further prevents rusting and iron taste pick-up[26].

Organic coatings adhere exceptionally well. Its surface is stable and resists pin point rust formation before enamelling, does not discolour during taking of enamels and also resists filiform corrosion after enamelling. Bending, drawing and impact tests showed that the coated material on the plate does not peel off as flake[40].

Advantages of TFS include ease of fabrication, strong corrosion resistance against acid and alkali solutions and salt water, strong resistance to sulphur staining and suitability for attractive printing[40]. Welding and side cementing enable full wrap around direct lithographic decoration by eliminating the impossible to print bare side strip that is the badge of the soldered seam as in the case of tinplate can[24]. Hinac coat plate has high corrosion resistance, good adhesion, good chemical and thermal resistance[1].

Stainless wirechrome has advantages like more brightness, and improved corrosion resistance and ease of fabricating either seamless or regular cans[22]. The advantages of forge welded seams included the use of lower cost TFS, superior can integrity with a side seam that is stronger than the base metal, high speed production, tolerance to high processing temperatures and resistance to greater internal pressures, less body material, flexibility in can shape, and improved and more reliable double seam[33].

The Hi-top material can be formed and drawn in the same way as tinplate or sheet steel. Heat resistance is good and although there is some colour change in the surface film above 150°C, rust resistance remains unchanged. Dewetting and eyeholing which occasionally occur in coating on tinplate with lacquer has not been experienced. Adhesion tests for Hi-top by Scotch tape method gave promising results[21].

Performance tests with TFS

TFS cans made by the Conoweld process have been subjected to the following tests[40].

1. Hot water bath for filled and sealed cans for 2 hr at 155°F to achieve equilibrium pressures at 95 psi.
2. Pressurisation of packed cans with 3.7 volumes of carbonation stored at 100°F for three months.
3. Vibration abuse to simulate shipping conditions, utilising packed cans with 3.5 volumes carbonation exposed to 180 vibrations per minute for 30-60 min.
4. Drop tests of filled cans in cartons (24 loose pack in each case) from heights greater than 10 feet.

Conoweld cans passed all these tests without side seam or double seam failure.

Tests show that after 30 days of exposure out doors there is no sign of rusting when lacquered. Hi-top TFS plates immersed in different solutions for 60 days gave favourable results as compared to E 2.8/2.8 electrolytic tinplate. For example, after immersion in a 3 per cent sodium chloride solution the quantity of iron dissolved was 3.7 per cent for Hi-top and 10.1 per cent for tinplate[21].

Product performance test

Tin free steel cans with enamelled interiors can be used for many products where cathodic protection usually supplied by tin is not needed. This would include many meat and vegetable products[40].

In Japan, TFS is used for packing sugar, cake, biscuits and oil, and non-food items like mineral oils, paints, organic solutions, etc.[1,21].

Tests with welded TFS cans indicate that the amount and rate of iron pick-up in beverage cans depend on the product, type of plate, surface type of end used and coverage of the organic coatings. The iron pick-up performance of the TFS can body for beer and soft

drinks has proved acceptable and comparable with that of tinplate cans[40].

Although affected by strong acids and alkalis, Hi-top cans withstand weak acids such as citric, lactic and acetic as well as weak alakali. There has been no rusting with organic solvents, oils and fats.

Simic and Djordjevic[44] conducted comparative storage trials with cured minced pork, cured pork pieces, cured beef pieces and pork with sauerkraut. The suitability of chromium plated 'Ancrolyt'[45] for packing fish products was investigated and compared with electrolytic tinplate. Over a period of one year chromium plated cans were found suitable for packing slightly or moderately corrosive fish products of low acidity.

Hottenroth[46] investigated the behaviour of electrolytically chromated steel cans (Ancrolyt cans) towards certain organic acids of different pH values in storage test lasting three months. The results of the investigation showed that the corrosive power of most of the acids increased with decrease in pH and that the anion of the acids played a decisive role in the dissolution of iron. In all the cases chromium pick-up was extremely small. Appearance of the can interior could not be correlated to the amount of dissolved metal.

Experiments were carried out by canning meat and fish products in plain and lacquered TFS and tinplate cans. Non pigmented epoxy phenolic lacquers and aluminium pigmented epoxyphenolic lacquers were used. Canned samples were tested after storing for 12 and 48 months at room temperature in plain and lacquered cans respectively. Non pigmented lacquered TFS cans were found suitable for canning meat products. Chromium content was not high in the products. However, products packed in TFS contained more iron as compared to tin cans.

In Poland, suitability of tin free steel cans for canning various fish products was investigated and compared with anodised aluminium and electrolytic tinplate cans. It was found that TFS cans were suitable for canning various fish products upto 24 months storage[47].

A new easy open all-steel can (TFS) offered by Continental Can Company was introduced in U.S.A. during 1970 for canning a number of vegetable, meat and fish products[48,49].

High quality cakes are vacuum packed in TFS cans so that the freshness, moisture content and texture are retained for some months. The cans are used as baking pans as well as package[50].

Barbeiri *et al.*[51] studied the suitability of various types of chromium coated steel against tinned steel for packing food products. Chromium coated steel plate (0.1 μm) was found to be comparable to E 2.8/2.8 type tinned steel (0.38 μm) in resistance to atmospheric corrosion and salt spray. Chromium plated steels have lower porosity, mechanical strength and higher resistance to sulphur containing foods. They were, however, not resistant to acid products. Varnishing with plastic material proved generally beneficial for non-edible products. For acid products, can constructed with tinned steel sides and varnished chromium coated steel base top proved satisfactory. In Japan also canning trials with a wide variety of food products are reported[52]. Tin free steel cans are being used for packaging beverages by many companies[23,24,29,30,53–59].

Economics in the introduction of TFS

Of the total cans made by a USA based company in 1976 roughly 65 per cent of beverage cans were made of steel and 35 per cent of aluminium. Of the 65 per cent of steel cans 32 per cent is tinplate cans and 33 per cent is tin free steel cans with cemented or welded side seam[40].

One major midwestern brewer saved about $ 480,000 during 1968 by using TFS can ends. A flat top TFS end costs about 32 cents less per 1,000 as compared to tinplate end. A typical FOB price structure for beer can body stock was $ 6.80 per base box in coils 26 in. wide or more; for tin free steel of the same base wieght, coating and coil width the cost was $ 5.45[26].

Cost of tin free steel can is said to run about $ 2 less per thousand (than equal number of tinplate containers)[24].

Melville[60] reported that the 1977-78 outlook for steel containers in America is seen as quite good. Increase of 2-3 per cent in tonnage of tin mill products has been estimated. Steel is more favourably placed than other packaging materials as regards energy because it is coal based.

Conclusion

From information available in literature introduction of tin free steel as an alternative to tinplate requires a major capital investment rather than comparatively minor conversion and hence economy would be a long range goal. But considering the upward trend in prices of tin due to its localised and limited resources and the indigenous availability of chromium, this long range economy goal can be reached earlier in this country. Improvement in handling conditions, electroplating technique coupled with development of suitable lacquers will accelerate the process of replacement of tinplate by TFS for atleast a few suitable products. A good start can be made by using TFS for dry foods such as biscuits and confectionery as also for oils and detergents.

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ERRATUM

In the article *Polyphenols of Avocado and their endogenous oxidation* by T. N. Prabha and M. V. Patwardhan in this Journal 1980, 17(5), 215–217.

FLAVONE should be read as FLAVAN throughout the article.

BOOK REVIEWS

On the Diphtheria of Diphtheria and Tetanus Toxoids Free from Medium Sensitizing Agents: by A. Koes-Darminta, Central Library, Baudung Instt. of Technology, Baudung, Indonesia, 1979, pp. 100.

One of the problems encountered in the large scale production of toxoids for human use is the possibility of contamination with sensitizing agents from the complex media in which the toxin producing organisms are grown. In order to overcome this, attempts have been made by the author to use chemically defined media avoiding macromolecular sources for nitrogen to support the growth of the organisms. Alternatively, the toxoid produced by growth in a complex medium can be purified by salt fractionation and gel filtration. The procedure suggested for tetanus toxoid is cultivation of the organism in stationary phase in Mueller-Miller's medium, detoxication of filtrate by formalin, ultrafiltration through colloid membrane salt fractionation and filtration through Sephadex G. 200. The product is now free from sensitizing agents. For the diphtheria toxiod the medium suggested is casamino acids supplemented with yeast extract. The purification of toxoid follows the same procedure as for tetanus. The report would be useful in planning production of the above two toxoids for public health measures.

C. R. KRISHNA MURTI
INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

Grain Processing Losses Bibliography: by Ruth Kasasian and D. A. V. Dendy, Tropical Products Institute, 56/62 Gray's Inn Road, London WC1 X 8LU, England, 1979, Price: £ 1.35, pp. 48.

This publication covers the losses occurring in shelling, hulling, milling, and in secondary processes like cooking, baking, fermentation, etc. excluding storage. In the present day all those engaged in the chain from processor to the consumer have realised the importance of overcoming losses which is evident from wide coverage of this publication and a compilation of this type will be more useful in this direction. It covers both quantitative and qualitative aspects of the losses and indicative abstracts are provided in most cases. Provision of cross reference under each section besides the index makes it complete by itself.

When one reads through the publication some references appear to be out of context and not relevant under the title of the publication. In contrast some glaring omissions are observed thereby deviating it from its comprehensive coverage. Such articles are: (1) Shivanna C. S., 1972, comparative costing of improved parboiling process in a modern rice mill as compared with traditional methods, *J. Fd Sci. Technol., Mysore*, 9(1) 7-9; Shivanna C. S., 1974, Economcis of pressure parboiling of paddy, *J. Fd Sci. Technol.*, 11(6), 286-287. Correction is needed in p. 31, k6. where the authors are Desikachar H.S.R. (not H.R.S.), Bhashyam M. K., Ranganath K. A. and Mahadevappa M. Any bibliography should indicate the period of coverage which is conspicuously absent in the present publication. Some references are too old to have any current interest, for example, the references of 1932 (P 12, c1), 1933 (P 28, J9) and 1943 (P 19, G17). Hope these will be taken care of by the authors in the future publication.

K. A. RANGANATH
CFTRI, MYSORE

Recommendations for Chilled Storage of Perishable Produce: International Institute of Refrigeration, 177, Boulevard Malsherbes 75017, Paris, France, 1979, Price: 35FF; pp. 148.

This brochure comprises eight sections dealing with the cold storage of perishable produce, devoting one section for each of the following commodities: Fruits and vegetables (section 2), Meat poultry and eggs (section 3), Fishery products (section 4), Dairy products (section 5), Cut flowers (section 6) and Seeds (section 7), thus covering the recommended conditions for all classes of perishable produce. The first section under the heading General introduction, covers the general principles considered in evloving the recommendations. The last chapter includes recommended chilled storage conditions for miscellaneous produce.

This is an updated version of the earlier brochure of 1967, with additional sections on chilled storage of cut flowers and seeds. In the preparation of the various sections the contributions of experts from various countries as consultants (list of experts given on pages 10-12) makes the brochure to provide maximum useful world wide scientific and technical information generated since the publication of the edition.

Needless to say that each section is very well prepared accompanied with useful information tables. The text

as well as titles of tables, appendices, etc. are presented both in English and French.

The brochure brought out recommendations for chilled storage of perishables based on up-to-date scientific and technological knowledge and I strongly feel that this brochure will be very useful for all those who are concerned with the chilled storage of perishables more particularly research workers, cold storage operators, traders and producers. A wider circulation of this brochure will help several countries in curtailing losses in perishables, particularly in developing countries.

P. NARASIMHAM
CFTRI, MYSORE

Safe Use of Pesticides: Technical Report No. 634 of WHO Expert Committee on Vector Biology and Control, WHO, Geneva, 1979, Pp. 44; Price: 5F

This report deals with the precautionary measures to be taken in the handling of pesticides, spraying of pesticides and the recommendations of WHO to minimize the health hazards. It contains the needs of developing countries regarding the safe use of pesticides and the factors influencing the toxicity of pesticides. Review of new data on pesticides for public health use containing insecticides for residual indoor-application of organophosphorus compounds carbamates, pyrethroids, larvicides have been described. The safe use of insecticides like Temephos, permethrin for louse control, biological control agents, rodenticides and the field observations on people exposed to pesticides, have been described.

The precautionary measures and the methods of monitoring exposure and the other aspects of the safe use of pesticides including education and training like field surveys of pesticide exposure, treatment of insecticide poisoning, expertise in toxicology, development of WHO recommended classification of pesticides, assistance in poisoning out-breaks and the summary of recommendations for national authorities and WHO are highlighted. This volume also deals with the treatment of poisoning due to organophosphorus, carbamate, and organochlorine insecticides like alleviation of life-threatening effects, removal of non-absorbed material and symptomatic treatment and the administration of antidotes.

This report will be useful to various Public health departments, Pesticide industries, Research laboratories and Government organizations.

K. VISHWESHWARIAH
CFTRI, MYSORE

Pesticide Residue in Food, 1977 Evaluations: Food and Agricultural Organisations of the United Nationas, Rome, 1979, Pp. 460.

This monograph contains summaries of the data considered by the joint meeting of the FAO Panel of Experts on Pesticide Residues and the Environment and the WHO Expert Group on Pesticide Residues. This document outliness the principles on which the evaluations were carried out and summarises the recommendations made thereto. Also it contains a summary of the evaluations made on residues in food of the various pesticides. The present document deals with the summaries of the data considered by the meeting together with the recommendations made for acceptable daily intakes, for maximum acceptable residue levels and for the methods of analysis.

K. VISHWESHWARIAH
CFTRI, MYSORE

Pesticide Residues in Food, 1977 Report: Food and Agricultural Organization, Rome, 1979, Pp. 80.

In this volume about 50 pesticides comprising organochlorine, organophosphorus, carbamate, herbicides, etc., are discussed. Under each compound, the explanation, evaluation for acceptable daily intake, toxicological studies, toxicological evaluation, residues in food and their evaluation, residues resulting from supervised trials, fate of residues, methods of residue analysis and comments are described.

With regard to the evaluation for acceptable daily intake, the biochemical aspects like absorption, distribution, excretion, biotransformation and metabolism are mentioned. Under toxicological studies, the data on special studies like mutagenicity, teratogenicity, carcinogenicity, observations in humans, antithyroid effect, shortterm studies, longterm studies, acute toxicity and special studies on reproduction are described. The data are available on residue in food and their evaluation like use pattern, residues resulting from supervised trials, fate of residues in animals, cranberries, apples, pears, residues in stored wheat, plants and soil.

Since this monograph gives valuable information on recommended maximum residue limits of certain pesticides in diffreent food commodities, it will be helpful to various Government organizations, Research laboratories, Industries and International trade.

K. VISHWESWARIAH
CFTRI, MYSORE

A Hand Operated Bast Fibre Ribboner: Rural Technology Guide: Trop. Prod. Inst, No. 7, by Beaurnmont J. H, Tropical Products Institute, 56/62 Gray's Inn Road, London WC 1X, 8 LU, 1979, Pp. 11, Price: 36. P.

This small illustrated guide describes a very simple gadget with which the fibrous bark of long thin stems of bast fibre plants can be peeled off easily by hand. The gadget consists of two rollers mounted vertically on two pins fixed in a large piece of wood. The fibrous bark can be peeled off by pulling back the two short ribbons of the prepeeled bark over the two rollers with the two hands. It is claimed that fibre from two stems can be peeled off simultaneously with the gadget.

Though the guide describes the gadget with exact dimensions and material requirements, using the idea, an intelligent rural artisan can always rig-up such a gadget by using materials available with him. He can even modify and improve the gadget to suit peeling off fibre from more than two stems at a time. The guide will be quite useful to the rural artisans and to the farmer.

P. VEERRAJU
CFTRI, MYSORE

SEMINARS

Second Indian Convention of Food Scientists and Technologists

The above Convention will be held on 19/20 February 1981 at the CFTRI, Mysore. Symposia will be on the following topics (1) Sensory analysis and consumer awareness; (2) microbial and other food contaminants; and (3) nutritional angles to food technology.

In addition, there will be a Poster Session on any aspect of Food Science and Technology. Summaries of papers for the poster session may be sent to the Hony. Exec. Secretary, AFST(I), CFTRI, Mysore - 570 013, before December 31, 1980. The registration fee will be Rs. 25 per head for AFST(I) members and Rs. 50 for others.

Oil Technologists' Seminar

Oil Technologists' Association of India, Southern Zone, Hyderabad is organising the 36th Annual Convention and a symposium on *Processing of Oilseeds, Oils, Byproducts and Derived Products: Techno-Economic Aspects* on February 14 & 15, 1981 at the Regional Research Laboratory, Hyderabad 500 009, India. For details, contact the Hony. Secretary, Oil Technologists' Association of India, Southern Zone. C/o Regional Research Laboratory, Hyderabad 500 009.

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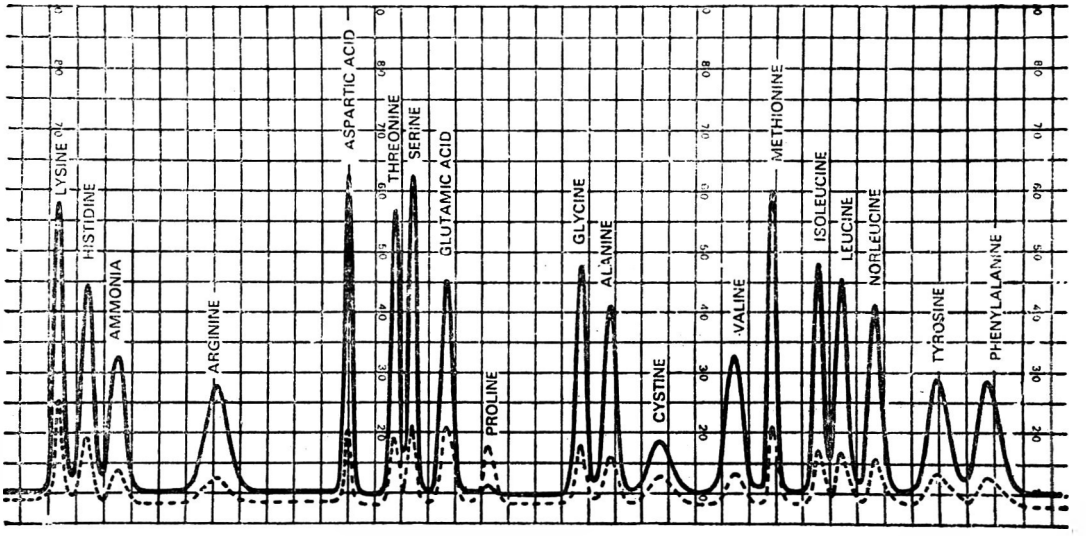

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SUBJECT INDEX

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INSTRUCTIONS TO CONTRIBUTORS

1. Manuscripts of papers should be typewritten in double space on one side of the paper only. They should be submitted in **triplicate.** The manuscripts should be complete and in final form, since no alterations or additions are allowed at the proof stage. The paper submitted should not have been published or communicated anywhere.

2. Short communications in the nature of Research Notes should clearly indicate the scope of the investigation and the salient features of the results.

3. Names of chemical compounds and not their formulae should be used in the text. Superscript and subscripts should be legibly and carefully placed. Foot notes should be avoided as far as possible.

4. **Abstract:** The abstract should indicate the scope of the work and the principal findings of the paper. It should not normally exceed 200 words. It should be in such a form that abstracting periodicals can readily use it.

5. **Tables:** Graphs as well as tables, both representing the same set of data, should be avoided. Tables and figures should be numbered consecutively in Arabic numerals and should have brief titles. Nil results should be indicated and distinguished clearly from absence of data.

6. **Illustrations:** Line drawings should be made with *Indian ink* on white drawing paper preferably art paper. The lettering should be in pencil. For satisfactory reproduction, graphs and line drawings should be at least twice the printed size. Photographs must be on glossy paper and contrasty; *two copies* should be sent.

7. Abbreviations of the titles of all scientific periodicals should strictly conform to those cited in the World List of Scientific Periodicals, Butterworths Scientific Publication, London, 1962.

8. **References:** Names of all the authors should be cited completely in each reference. Abbreviations such as *et al.*, should be avoided.

   In the text, the references should be included at the end of the article in serial order.

   Citation of references in the list should be in the following manner:

   (*a*) *Research Paper:* Menon, G. and Das, R. P., J. sci. industr. Res., 1958, **18,** 561.

   (*b*) *Book:* Venkataraman, K., The Chemistry of Synthetic Dyes, Academic Press, Inc., New York, 1952, Vol. II, 966.

   (*c*) *References to article in a book:* Joshi, S. V., in the Chemistry of Synthetic Dyes, by Venkataraman, K., Academic Press, Inc., New York, 1952, Vol. II, 966.

   (*d*) *Proceedings, Conferences and Symposia:* As in (*c*).

   (*e*) *Thesis:* Sathyanarayan, Y., Phytosociological Studies on the Calcicolous Plants of Bombay, 1953, Ph.D. thesis, Bombay University.

   (*f*) *Unpublished Work:* Rao, G., unpublished, Central Food Technological Research Institute, Mysore, India.

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Research Papers

Research Notes

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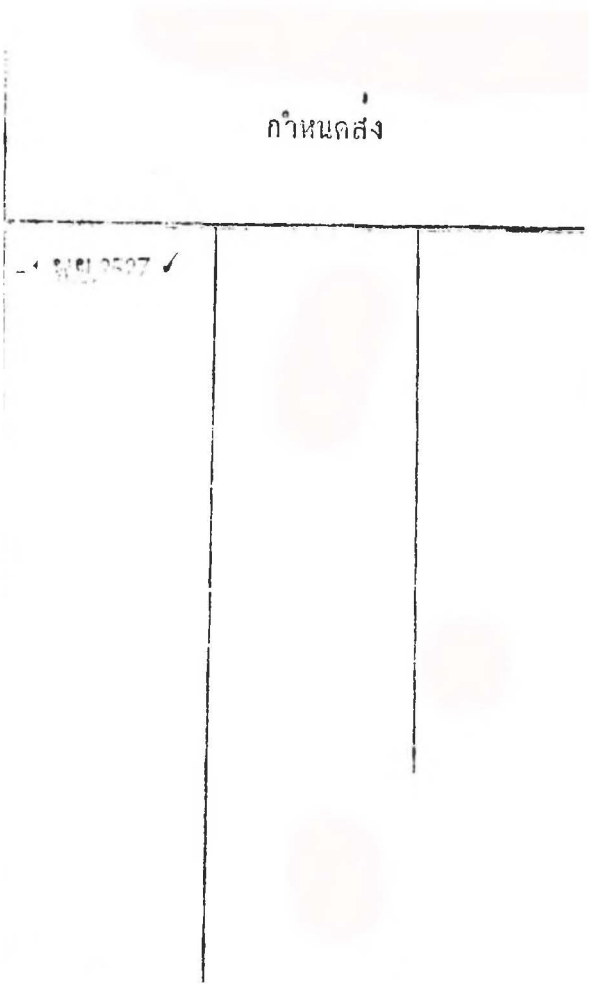
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